A Seven-Day Journal

Credit and Industry.

IN the course of a speech made at the thirteenth annual general meeting of United Dominions Trust, Ltd., which was held in London on Monday, July 22nd, Mr. J. Gibson Jarvie, the chairman and managing director of the company, spoke of the benefits which accrued from the wise use of credit. If only British merchants and manufacturers would, he said, realise a little more clearly the importance of credit in the distribution of merchandise and wares, and if they would only see the possibilities of the home market from a credit point of view, far more business could be done and a greater measure of industrial activity would ensue. Business, he held, was there to be done if our business people would only do it. That the use of credit had been abused in some cases was true, but the measure of its abuse was as nothing to the fact that it was largely to the wise use of credit that Great Britain owed the proud position which it holds to-day as a trading community. Credit for distribution purposes, Mr. Gibson Jarvie said, while being the most misunderstood form of credit, was the type of credit which called loudest for expansion. Its intelligent use could do much to bridge the gap between large-scale production and the existing underconsumption of the products of industry. The wise use of credit was the finest form of thrift.

New Motor Vehicles.

IN the monthly report of the Society of Motor Manufacturers and Traders, it is stated that the number of motor vehicles registered in Great Britain in May amounted to 37,733, as against 35,051 registered in the corresponding month of 1934, an increase of 7·7 per cent. Private cars included in these figures amounted to 24,960 against 22,221, a rise of 12·3 per cent.; while goods vehicles of various types amounted to 5459, as against 5727 in 1934, a reduction of 4·7 per cent. Since September, 1934, the total production of private cars and taxicabs to date in this country amounted to 217,532, as against 185,171 during the same period last year, while for commercial vehicles the figures are 63,892 and 58,130. In the private car market £140,758 worth of vehicles was imported and £468,025 worth was exported in the month of June; while in the commercial vehicle field £4309 worth was imported and £787,864 was exported. The most interesting fact revealed by the report is the increase in the number of oil-engined vehicles registered as "Hackneys," in May, 1935, amounting to 4320, as against 1751 registered in May, 1934, an increase of 146·7 per cent. This figure, following as it does on the increased taxation of oil-engined vehicles, mentioned in the Seven-Day Journal of April 19th last, shows that in spite of the new duties the high-speed oil engine continues to increase in popularity among road users.

Safety at Sea.

SPEAKING in the House of Commons on Thursday, July 18th, Mr. Walter Runciman, President of the Board of Trade, announced that he had appointed a committee of experts to inquire in the interests of safety at sea into the types of steering gear used by the steamships "Usworth" and "Blairgowrie," into whose loss public inquiries were recently held. The Chairman of the Committee, which will sit in private, is Mr. H. N. Gresley, the Chief Mechanical Engineer of the London and North-Eastern Railway Company, and its members are Mr. Maurice S. Gibb, managing director of the Central Marine Engine Works, West Hartlepool; Mr. J. Denham Christie, chairman of Swan, Hunter and Wigham Richardson, Ltd.; Captain Thomas, marine superintendent of the Furness Line; and Mr. W. R. Spence, the general secretary of the National Union of Seamen. The Mercantile Marine Service Association and the Imperial Merchant Service Guild, the societies representing British ship masters and navigating officers, have sent a joint protest to the President of the Board of Trade referring to the non-inclusion of direct representatives of masters and officers in the Committee. The inquiry into the manning of British ships, which Mr. Runciman stated will follow the recent findings of the court of inquiry into the loss of the "Usworth" and "Blairgowrie," will be made by the Board of Trade Merchant Shipping Advisory Committee, on which masters and officers are directly represented.

A New London Exhibition Centre.

WORK is to be begun almost immediately on the erection of a new exhibition building at Earl's Court, which will cost £1,250,000, and will, it is expected, provide direct employment for some 2000 men for a year and a half. The building will be constructed by a company formed under the auspices of the British Pacific Trust, and a long lease of the Earl's Court Exhibition site, covering nearly 19 acres, has been granted by the London Passenger Transport Board. The new building is to be completed by the end of 1936, so that the 1937 British Industries Fair and the other annual exhibitions of that year can take place in it. The main structure will consist of a concrete building, 80ft. high, with a capacity of 42,700,000 cubic feet and a weight of about 180,000 tons, in which about 50,000 tons of cement and 10,500 tons of reinforcing and structural steel will be used. The space given by the ground floor and the first floor will amount to 12 acres, and in the pillarless area a swimming pool, with a length of 200ft. and a width of 100ft., will be built with a mechanically operated cover. On the second floor a series of conference rooms, restaurants, and a banqueting hall are to be provided. New systems of electric lighting, air conditioning, and fire protection are to be embodied in the design, and good access to the building and site will be provided for road, rail, and tube traffic. The principal designer and architect is Mr. C. Howard Crane, of America, who will be assisted in an advisory capacity by Mr. Gordon Geeves, of London. Dr. Oscar Faber will be responsible for the structural and mechanical engineering work, and the chief contractors are the Hageman-Harris Company.

Technical Education in Europe.

IN order to obtain information which might be of assistance to them in connection with the proposed new Central School for technical, commercial, and art studies, a deputation of the Birmingham Education Committee has visited numerous technical colleges and modern educational establishments in different parts of Holland, Belgium, France, Switzerland, Austria, and Germany. In all, about twenty colleges and schools were visited, and the report has now been issued. The deputation was impressed by the importance attached to technical education by the industries as well as the Governments concerned. In all the countries visited a much higher degree of co-operation between industry and education was in evidenee than was to be found in this country. In some cases groups of firms had contributed money to put up educational and research institutions. In Switzerland and Austria this co-operation takes the form of compulsory part-time day classes for apprentices. Members of firms are encouraged to take technical classes in the daytime. In France and Belgium a special tax on industry provides for the development of technical education. No opposition is made to technical institutions doing practical work on a commercial basis. Full-time training is available ranging from purely trade courses to those of university standard. It seems to be generally recognised that for responsible posts the standard of technical education required has risen beyond the level attainable by part-time study within a reasonable number of years. Our system, which may require full-time attendance at evening classes between the ages of fourteen and twenty-five, is looked upon as depriving the student of important social and cultural activities.

The "Normandie" and the "Queen Mary."

ON Saturday last, July 20th, the French liner "Normandie" paid a visit to British waters, and a distinguished company of guests, including leading shipbuilders and engineers, was privileged to inspect the ship in Cowes Roads. The party was officially received by Messieurs Cangardel, Marie, and Malglaive. At the luncheon, in welcoming the guests, Monsieur Pierre de Malglaive made special mention of the presence of Sir Thomas Bell and Mr. S. J. Pigott, of John Brown and Co., Ltd., and wished the "Queen Mary" most heartily every success in her career. Speaking of the advantages of the big ship, Monsieur de Malglaive said that the results of the first voyages of the "Normandie" had clearly pointed in the direction of showing that the big ship was less expensive to build and to run per ton and per head of passenger carried than was the smaller ship, giving, in addition, more speed, more comfort, and more amenities to her passengers than smaller ships, without raising excessive difficulties in handling. He expressed hope that the world's shipping would soon be adjusted for harmonious and successful working. In replying for the guests, Mr. Walter Runciman, President of the Board of Trade, referred to the arrangement between the Compagnie Générale Transatlantique and the Cunard-White Star Line for a joint schedule of sailings for 1936 and onwards. Mr. Runciman said that the owners of the "Normandie" had assured him that the "Normandie" and the "Queen Mary" would not be competitors in the wide sense of the term, but co-operators.

Heston Airport.

ON Friday, July 19th, the new central repair and aeroplane maintenance station at Heston Airport was formally declared open by Sir Philip Cunliffe Lister, the Secretary of State for Air. The main hangar, which has workshops on three sides, is designed to admit aeroplanes with a wing span up to 200ft. The total floor space of the hangar is 32,450 square feet, and is so laid out that repair work can proceed in the different departments in proper sequence. An upper floor is used as offices for administrative work, and special heating and lighting schemes are provided. The area of the landing ground has been increased by about 45 acres, and efficient ground lighting is installed, while a wireless beam for guiding aircraft in foggy weather is to be experimented with. In the course of his speech, Sir Cunliffe Lister congratulated Mr. H. N. St. V. Norman and Airwork, Ltd., on the station. Referring to the co-operation between the Air Ministry and other Government Departments, such as the Post Office, the Ministry of Transport, and the Dominions Office, which had led to developments in aviation, he said that the Air Ministry was particularly anxious to encourage co-operation; not only that between the various branches of aviation, but also co-operation of the kind which should be Imperial and international as well as national in character.

Concrete for Dam Building.

A REPORT has just been issued by the Department of Scientific and Industrial Research, Building Research Branch, entitled "Correlation Between Laboratory Tests and Observed Temperatures in Large Dams," by Dr. N. Davey, in which some interesting figures are given as to the rate of change of temperature in large concrete masses compared with laboratory tests under approximately similar conditions. In the report stress is placed on the importance of selecting the right type of cement for concrete work, and it is stated that a committee of the International Commission on Large Dams of the World Power Conference has been appointed to deal with the matter. The report is compiled from figures taken in the construction of the Tongland and Clatterinshaws dams of the Galloway water power scheme, and the Laggan Dam of the Lochaber water power scheme, figures being obtained as to internal temperatures by maximum-reading thermometers placed in tubes built into the mass. The report stresses the value of cement having a low heat-generation value during setting, and covers several types. The experiments showed that two temperature peaks are reached, the first, with great rapidity, owing to heat received from the preceding lift. This is followed by a gradual fall, which is arrested by heat received from the preceding lift. As a result, with similar lifts of the same mix, the first peak temperature is dependent on the age of the preceding lift, while the second peak temperature is dependent on the time interval before the succeeding lift is placed. Data which have been published on the recently constructed Pine Canyon Dam in America enabled additional checks to be made on the method of determination of the temperature rise outlined in the report.

A Proposed New United States Liner.

ON his arrival from New York at Plymouth on Tuesday, July 23rd, Mr. James S. Mahool, the general passenger traffic manager of the International Mercantile Marine Company, announced that a new 30,000-ton liner, the largest and fastest ever built in the United States, will probably be running between New York and Europe in 1937. The plans for the ship have already been prepared, and she should be in commission within two years. Her designed speed will probably be two knots greater than that of the 20-knot liners "Manhattan" and "Washington." Mr. Mahool is returning to America on the "Normandie," but he does not think that although more Americans are travelling to Europe, there will ever be sufficient traffic to make such large ships as the "Normandie" and the "Queen Mary" paying propositions. This year's increase in the number of passengers is largely to be attributed, he says, to the Jubilee celebrations in England, but on the whole it seems that most visitors prefer to pay lower rates and to travel on slower and smaller liners.

An Important London Road Scheme.

THE Highways Committee of the London County Council has decided to recommend the promotion of legislation jointly with the Middlesex County Council to carry into effect the Cromwell-road to Great West Road improvement scheme. It is estimated that the total gross cost of the undertaking, including the Middlesex portion, will be £2,320,000. The part of the scheme which falls within the County of London will cost £1,620,000 gross and £1,470,000 net. The grant from the Road Fund on the basis of 60 per cent. of the net cost will be £885,000. The extension of the Cromwell-road westward was the subject of a Bill by the Metropolitan Board of Works in 1889, but it was not proceeded with, and has since been mentioned from time to time. In recent years the scheme has become much more important owing to the construction of the Chertsey By-pass, the Great West Road, and the North Circular Road, considerable sections of which are now in use. The proposed new road would have a total length of 3·7 miles, of which nearly 2 miles would lie in the County of London. The scheme in London provides for a new 80ft. wide road bridge over the West London Extension Railway and a widening of the Great Church-lane Bridge over the Metropolitan, District and Piccadilly Railways to 85ft. A roundabout would be constructed at the junction of the proposed road with Hammersmith Bridge-road. The Highways Committee believes that in magnitude and potential traffic value the improvement is one of the most important ever submitted to the Council.

The Differential Analyser.

No. II.

(Concluded from page 58, July 19th.)

WHILE the torque amplifier overcomes almost completely errors arising from the slipping of the integrating wheel it leaves untouched another source of error of nearly equal importance—the existence of backlash at various points of the mechanism. The means adopted to eliminate the effect of backlash vary with the nature of the drive in which it occurs. The direction of rotation of the leading screw in Fig. 2 has to be reversible in order to cover the requirements of a curve which rises and falls. There must be no lost motion at the maximum and minimum points and therefore no backlash between the leading screw and the carriage. At this point backlash is eliminated by connecting the carriage to the screw through two nuts which are pushed apart by spring-pressed wedges inserted between them. If the wedge angle is correctly selected the arrangement gives a positive drive in either direction without backlash and at the same time allows slight irregularities in the screw to be accommodated without the drive binding.

The equivalent of a double nut is provided for the rotational drive of the disc Fig. 2 by engaging the worm wheel with two worms, one on each side of it, mounted on parallel spline shafts. The two shafts are coupled together by equal gear wheels. A "lash lock" coupling similar to that used for the leading screw is fitted in conjunction with these gear wheels in such a way that one worm is effective for driving the disc in one direction and the other for driving it in the other direction. At the same time the lash lock eliminates the effect of backlash in the two gear wheels coupling the spline shafts together.

Elsewhere in the machine its operation calls for the coupling together of various shafts through gearing. The effect of a given amount of backlash in any one of these drives will diminish with an increase in the number of revolutions of the shaft required to produce a given result. For example let the result for which the unit is responsible be a linear movement of a pencil or other part of, say, 1in. If this movement is produced by one rotation of the driven shaft and if there are $n°$ of backlash between that shaft and its driver then assuming that the line or movement starts at a reversal in the direction of the drive it will be short of its true length by n/360th of an inch. If the result is produced by two rotations of the driven shaft the same amount of backlash will produce only half this discrepancy. Hence at many points the effect of backlash can be substantially eliminated first by very careful workmanship and second by arranging the machine in such a way that the driven shaft makes a large total number of revolutions in the course of a problem.

It is not possible or desirable to rely on this procedure at all points in the machine where backlash may occur. At especially important points devices known as "frontlash" units are introduced which have the effect of reducing backlash errors to a second degree order of importance. When the driving shaft reverses its direction of rotation backlash causes the driven shaft to lag behind its true position until the next reversal occurs. The "frontlash" unit is a device designed to act as a rigid coupling at all times except momentarily just after the driving shaft reverses when, during the first revolution of that shaft in the new direction, it speeds up the driven shaft to about 10 per cent. faster than the driver, thereby making good the backlash lag. The error introduced is confined to the short overspeed period.

The design of the frontlash unit is represented in the diagram Fig. 9. The input or driving shaft

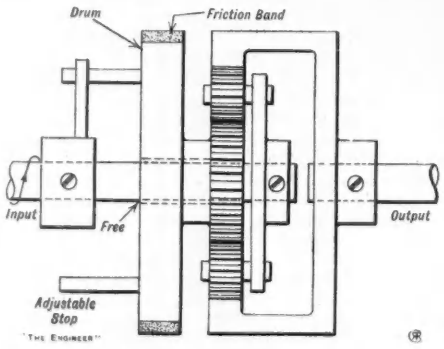


FIG. 9—"FRONTLASH" UNIT

carries, freely mounted upon it, a drum the periphery of which is engaged by a friction band. Two adjustable stops project from the drum one or other of which, according to the direction of rotation, engages with an arm fixed to the input shaft. The boss of the drum carries the central wheel of a sun and planet system, the planetary wheels being mounted on a disc fixed to the end of the input shaft. With the planet wheels there engages an internal gear wheel fixed to the end of the output shaft. As sketched the arm on the input shaft is pressing against one of the stops on the drum. In this condition there is no relative movement of any of the parts. The input and output shafts are moving as if they were one, the only difference being that the drive is slightly less free than it would otherwise be by virtue of the fact that it has to be made against the resistance of the friction band within which the drum revolves. When the direction of rotation of the input shaft reverses there is a short interval during which the drum is not driven namely the interval t, say, during which the arm on the input shaft is turning through the angle, α say, between the stops on the drum. During this interval the drum and sun wheel are held stationary by the friction band. The planet pinions are however driven round by virtue of the fixed connection of their disc to the input shaft. The drive is therefore transmitted through them and the internal gear to the output shaft, the gear ratios being such that if ω is the angular velocity of the input shaft that of the output shaft during the interval t will be about $1 \cdot 1\ \omega$. The interval ends when the arm on the input shaft makes contact with the second stop. Thereafter the drive resumes the 1 to 1 ratio of a solid coupling.

Let β be the angle of backlash which the device has to take up. This angle is the relative advance or creep which the additional 10 per cent. velocity has to communicate to the output shaft during the interval t. We therefore have $\beta = {}^1/_{10}\ \omega\ t$. During the time t the input shaft will move through an angle $\omega\ t$ and this angle will be equal to α, the angle between the stops on the drum. We therefore have $\alpha = 10\ \beta$ or the angular setting of the stops is about ten times as large as the angular backlash to be eliminated. The position of the stops can therefore be adjusted with great accuracy.

The frontlash units are self-contained fittings which may be inserted at any necessary point in the mechanism of the machine. One of their applications is to eliminate the backlash which as previously noted is present in the torque amplifiers.

It will now have been gathered that the anatomy of the complete machine includes mechanical integrators, torque amplifiers, input and output tables, counters of the cyclometer type and devices for eliminating the effect of backlash. In addition, as indicated in the photographs of the Manchester machine which we have reproduced, there are also included a large number of shafts some running longitudinally and some transversely. These shafts may be coupled together in an almost infinite variety of ways. Some of the shafts may be driven directly by a motor in order that their displacement may represent time or some other independent variable. Others may be coupled together in such a way that the displacement of one is the sum or difference or the product or dividend of the displacement of two others. Yet others may derive their motion from the manual operation of the pointer on one of the input tables. Others still may derive it from the torque amplifier of one of the integrators and pass it on to one of the output tables or to a second integrator or through an adding or multiplying device to yet another of the longitudinal or cross shafts. The setting up of the machine depends entirely upon the nature of the problem to be solved. It demands in most cases a large amount of skill and mathematical knowledge and generally constitutes the principal portion of the task of solving a given problem.

Of the devices mentioned in the above paragraph, but not previously described, we need only say that those designed to add the displacements of two of the shafts consist of differential gearing, while the product of one displacement by another is obtainable through a multiplier consisting of an arrangement of screwed shafts. In addition any of the longitudinal shafts may be coupled to its neighbour through spur gearing of selected ratio, thereby making the displacement of the second shaft a constant proportion of that of the first. Finally any of the longitudinal shafts may be coupled to any of the transverse shafts through spiral gear boxes transmitting right or left-hand motion.

It is hardly necessary to say anything more than we have already said regarding the use of the machine in its capacity as a recording planimeter, or integraph. When the problem to be solved consists simply of the integration of a known curve which can be laid down on one of the input tables the method of working the machine can be readily understood in the light of our description of its parts. It is not, however, self-evident how the machine is employed to solve a differential equation of a type which does not present us with a curve which can be laid down on the input table. This is by far the most important and interesting aspect of the work which the machine can perform. We will deal with it by giving a particular example. It should however be noted that while each problem calls for a particular method of attack certain general methods of approach have been established which simplify the discovery of the best method of setting up the machine to deal with it.

The problem which we have selected for illustrative purposes is one previously mentioned, namely that of a body moving under the conditions of a damped vibration with the damping resistance proportional to the square of the vibrational velocity at any instant. In order to obtain numerical coefficients let us suppose that the body has a mass of 10 lb., that the restoring force is equal to 30 times the displacement and that the damping force is 5 times the square of the velocity. The differential equation to the motion of the body will therefore be

$$\ddot{x} + \tfrac{1}{2}\ (\dot{x})^2 + 3\ x = 0 \quad . \quad . \quad . \quad . \quad (6)$$

The problem is to draw a curve which will show the displacement x of the body at any instant t. To this curve we may add another showing the velocity of the body at any instant.

Writing equation (6) in the form

$$\dot{x} = -\int \left\{ \tfrac{1}{2}\ (\dot{x})^2 + 3\ x \right\} dt \quad . \quad . \quad . \quad (7)$$

we see at once that if we knew how $\dot{x}$ and x varied with the time we could draw a graph, on a time basis, of the expression within brackets on the right. This graph laid down on the input table could be readily integrated by the machine which would give on the output table a graph of the velocity $\dot{x}$ on a time basis. Transferring this output graph to the input table we

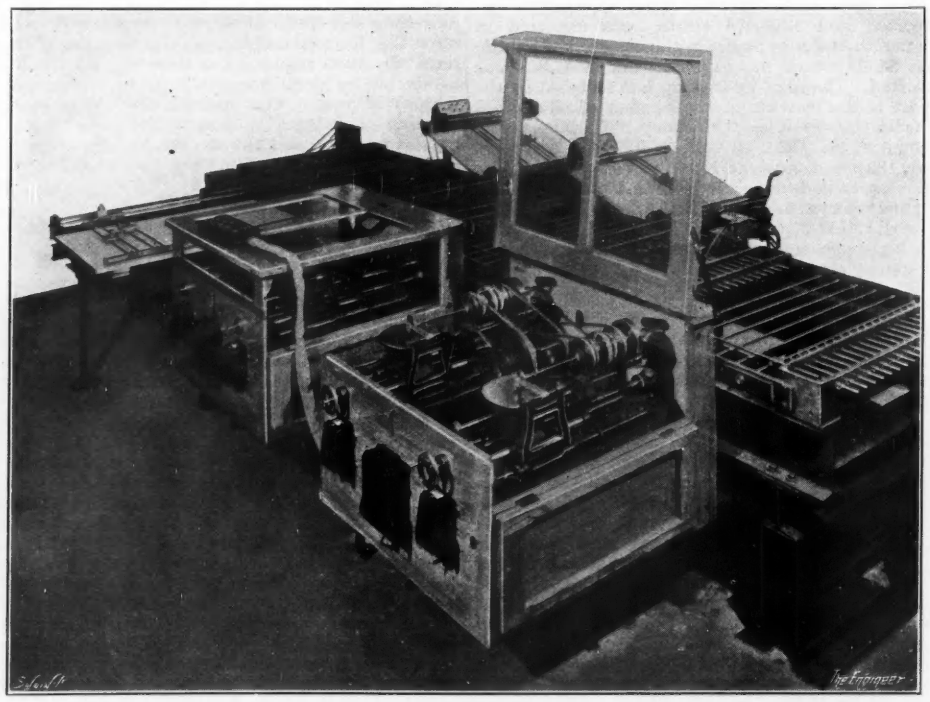


FIG. 10—INTEGRATORS AND TORQUE AMPLIFIERS IN FOREGROUND; INPUT TABLES IN BACKGROUND

DIFFERENTIAL ANALYSER AT MANCHESTER UNIVERSITY

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD., ENGINEERS

COUNTERS AND BASE FOR CAMERA ON THE LEFT: OUTPUT TABLE ON THE RIGHT

could repeat the process, obtaining this time a graph of the displacement x. This procedure is, of course, impossible because it is based on an initial knowledge of $\dot{x}$ and x, the very quantities which it is our task to determine. The method of attack about to be explained would appear perhaps to rest on the same illogical procedure. Actually, however, it is just as logical as, and indeed closely similar to, the familiar algebraic process of giving an unknown quantity a symbol, such as x or y, manipulating that symbol in accordance with the conditions of the problem and establishing an equation from which the value of the unknown can be deduced.

In Fig. 11 let A be one of the longitudinal shafts of the machine. Let us suppose that by some means or other its motion represents the term $3x$ in equation (6), that is to say, the extent of its rotation from its zero position is a measure of three times the displacement of the vibrating body at the same instant from its zero position. Similarly let B be a second shaft and let its motion represent the term $\frac{1}{2}(\dot{x})^2$ of the same equation. We do not know at present what these motions are or how they are communicated to the shafts.

By means of an adding device L let us add the motions of A and B together and transfer the sum to a third shaft C. Let M be a mechanical integrator of the type previously described. Its disc is shown coupled to a fourth shaft D, which is supposed to be driven by a motor. The motion of D and the rotation of the disc of the integrator will therefore represent time. Couple the shaft C to the leading screw of the integrator in order that its motion may determine the distance of the integrating wheel from the centre of the disc. Then from what we already know concerning the action of the integrator, the output of the integrating wheel will be the quantity represented by

$$\int \left\{ \tfrac{1}{2}(\dot{x})^2 + 3x \right\} dt.$$

This quantity from (7) above is equal to $\dot{x}$. Transfer the output of the integrator M to a fifth shaft E.

Let N be a second mechanical integrator the disc of which is also driven from the time shaft D. Let the output of the first integrator be transferred from the shaft E to the leading screw of the second integrator. Then the output of the second integrator will be the quantity represented by

$$\int \dot{x}\, dt \text{ or } x.$$

Transfer this output to a sixth shaft F.

Studying this diagram we see at once that the motion of shaft A is simply three times the motion of shaft F. If then shafts A and F are coupled by gear wheels P of 3 to 1 ratio one of the missing links in the cycle will be supplied. In other words shaft A will possess the required unknown motion if shaft B has its required unknown motion.

Further study shows that the motions of shafts E and B are related in so far that each involves $\dot{x}$. To close the second link in the cycle we have to connect E and B by some means that will multiply the motion of E by $\frac{1}{2}\dot{x}$. We cannot employ gearing in this case for the multiplying factor is an unknown variable, not a known constant. The result can however be achieved by means of an input table Q on which there is laid down a graph of the curve $y = \frac{1}{2}z^2$. The bridge of the input table is coupled to the shaft E and moves across at the rate determined by the motion of that shaft. The manually operated pointer mechanism is connected to the shaft B. Hence as the operator turns the handle to keep the pointer

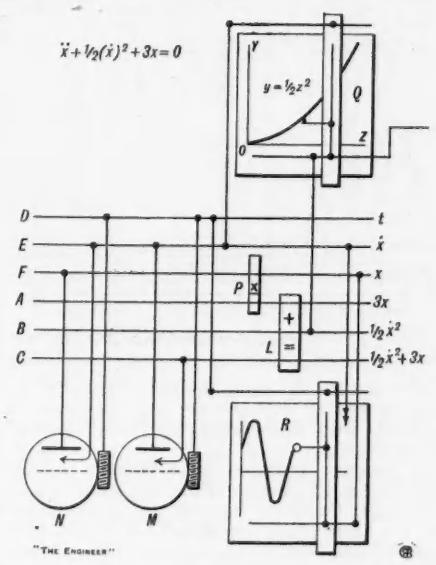


FIG. 11—SOLUTION OF A DIFFERENTIAL EQUATION

on the curve as the bridge moves across the table he will impart to the shaft B motion representing $\frac{1}{2}(\dot{x})^2$.

The mechanical solution of the problem is completed by coupling the shaft F to the pen-operating mechanism of an output table R, the bridge of which is driven across by a connection taken from the time shaft D. The curve drawn by the pen will show the displacement x on a time basis. A similar connection may be taken from the shaft E to a second output table or to a second pen on the table R. The curve drawn in this case will be that of the velocity $\dot{x}$ on a time basis.

Any air of unreality which may appear to be associated with this description of the action of the machine will, we think, disappear if the drive of the various parts is traced back to the power-driven time shaft or to the handle of the input table, the presence of the necessary torque amplifiers in series with the integrators being assumed. It will be found that once the time shaft starts to move, the input handle being turned manually as prescribed, all the other parts will acquire motion. If they move at all they can only move in the manner implied in our description and if they move in that manner the stated result will follow.

The speed of the time shaft need not be constant. If it varies, the motion of all the other parts will vary proportionately and as a result the only effect produced will be a variation in the rate at which the curve is drawn on the output table. A variable speed motor is actually used to drive the time shaft and is slowed down when required to enable the operator to follow any difficult portion of the curve on the input table. That curve, in order to obtain an increased scale, may be divided into two or more portions, each occupying the full available width of the table. The machine is stopped while the pointer is being carried back from the end of one portion to the beginning of the next.

In the example given in Fig. 10 it so happens that the third term is a simple numerical multiple of x. As a consequence shafts F and A can be coupled by gear wheels of the required ratio. In other equations the third term might be one which could not be obtained by a simple gear coupling. It might for example be of some such form as $(3x^2 + 4x + 5)$. The coupling of the shafts F and A in this case would be effected by means of a second input table, the pointer of which would be under the charge of a second operator who would guide it to follow the curve $y = 3z^2 + 4z + 5$ previously plotted and laid down on his table. Similarly the second term might be a complicated function of $\dot{x}$. The only difference would be in the form of the curve plotted on the first input table. In other words, the machine can deal, with equal facility, with all equations of the form

$$\ddot{x} + f(\dot{x}) + g(x) = 0,$$

where $f(\dot{x})$ and $g(x)$ are known functions of $\dot{x}$ and x which can be plotted.

It will be noted that our example represents the mechanical solution of a differential equation of the second order and that two integrators are required to handle it. With three integrators third order equations can be handled and so on.

The setting up of the machine may take half a day to a day but once it is set up the solution is obtained in 10 to 15 minutes. Having been set up it may quickly be reset to deal with the same equation with one of the constants changed. In this way very valuable information may be obtained with little

expenditure of time beyond that spent on the initial setting up.

These remarks are not intended in any way to exhaust the range and power of the machine. Its capabilities from the mathematical point of view are almost unlimited. To describe them adequately would however weary the non-mathematical reader and far exceed the space at our disposal.

The idea underlying the machine is not new. It is almost in fact contemporaneous with the birth of the calculus. Over 200 years ago Leibnitz, who shares with Newton the credit for having invented that branch of mathematical science, foresaw the possibility of constructing a mechanical analyser and went some considerable way towards realising a practical machine. His ideas were however far in advance of the mechanical achievements of his day. In 1876 Sir William Thomson (Lord Kelvin) in a paper before the Royal Society suggested the use of the mechanical integrators, developed by his brother James, for the purpose of solving linear differential equations of the second order with variable coefficients. In his case also the idea was before its time. From that date onwards several attempts were made to construct analysers adapted to restricted duties. One such machine was, we believe, constructed some years ago at the Royal Aircraft Factory, Farnborough, for dealing with particular types of equation.

It remained however for the Massachusetts Institute of Technology to develop the analyser on the lines we have described. While many people shared in the development principal credit must be given to Dr. V. Bush of the Institute. The two great mechanical problems in the design, the construction of a satisfactory torque amplifier and the devising of means to eliminate the effect of backlash, were solved by or in conjunction with Mr. C. W. Niemen of the Bethlehem Steel Corporation. The Massachusetts machine has eighteen longitudinal shafts, six integrators, four input tables, and one output table, with two pencils. The tables are of sufficient size to carry diagrams measuring 18in. by 24in.

A second similar machine has now been installed at the University of Pennsylvania, a third at Manchester University and a fourth is in course of construction at the Astrophysical Institute at Oslo. The Manchester machine was constructed by the Metropolitan-Vickers Electrical Company, Ltd. It follows the Massachusetts machine in its general design but some modifications suggested by Dr. Bush and others by members of the builders' Research Department have been introduced. It has at present four integrators and two input tables but it will shortly be enlarged by the addition of four other integrators and probably four more input tables. The machine in its present condition occupies a floor area of 27ft. by 10ft. Its construction and assembly demanded, as our readers will fully realise, engineering skill of the highest order, tool-room limits being worked to throughout. It is pleasant to be able to record that the Metropolitan-Vickers Company undertook the construction of the machine more as a co-operative venture than as a commercial contract. To Messrs. Newman and Guardia credit is owing in connection with the development and construction of the high-speed automatic camera employed for photographing the counters associated with the integrators as an alternative means of recording the results.

Balancing of Three-Cylinder Locomotives.

By F. L. BAXTER.

IN general, the balancing of locomotives within recent years has scarcely kept pace with other advances in design, and three-cylinder units are not above the average. The fault found in most cases is the excessive percentage of reciprocating weight which is balanced, for the old rule of two-thirds as the correct proportion is usually more than is required with the long and heavy engines of to-day.

Reciprocating masses are balanced in order to check nosing movements and to eliminate small variations in the draw-bar pull, but the large moment of inertia of big modern types causes a greater resistance to the nosing oscillations, and the balancing of a lesser percentage of the reciprocating masses will give steady riding. Three-cylinder engines with cranks at 120 deg. or thereabouts have a greater nosing moment than two-cylinder engines with reciprocating weights of the same weight per set, but this is usually counteracted by the smaller size of the reciprocating parts of a three-cylinder engine of equal power.

A reduction in the proportion of the reciprocating weight to be balanced brings about a reduction in the size of the balanceweight in the wheel, which assists in reducing the hammer blow and also the lateral blow of the wheel against the rail. Locomotives of the three-cylinder type with equally spaced cranks have completely balanced horizontal forces, and also have a complete balance of the secondary forces resulting from the obliquity of the connecting-rod. But they have an unbalanced horizontal couple which can be countered (in a locomotive) only by revolving masses placed in the wheels. As these are, in addition to the weights required to neutralise the effect of the revolving parts, they produce excess balance. In practice, although the horizontal forces are balanced, the horizontal couple is of great magnitude, and in an express locomotive particular attention should be devoted to the elimination of its effects. The horizontal couple is given by

$$C_h = 2 \cdot 12 \ M n^2 r d \text{ ft.-lb.} \quad . \quad . \quad . \quad . \quad (1)$$

in which

M = Weight of reciprocating parts per cylinder, lb.
n = Number of revolutions per second of wheels.
r = Radius of crank throw, feet.
d = Distance between inside and outside cylinder centres, feet.

Assuming that the inside and outside reciprocating parts are of the same weight at 820 lb. (for actual weights, see Table I), the horizontal couple of the

TABLE I.—*Weight of Reciprocating Parts.*

	Cylinder. Inside. lb.	Outside. lb.
1 piston and rings	160	160
1 piston-rod and nut	168	168
1 inside crosshead and arm	350	—
1 outside crosshead and arm	—	371
1 inside connecting-rod (part)	125	—
1 outside connecting-rod (part)	—	140
Total	803	839

British-built Argentine 4–8–0 locomotive, whose balancing is considered in this article, is

$$2 \cdot 12 \times 820 \times 4 \cdot 5^2 \times 1 \cdot 083 \times 3 \cdot 81 = 145{,}500 \text{ lb.-ft.}$$

if the whole of the reciprocating masses are balanced. With a proportion of two-thirds balanced, the horizontal couple is 97,000 lb.-ft., and as the distance between the balanceweights is 5·75ft., the hammer blow is 16,900 lb. This hammer blow, of course, can be divided up over a number of wheels.

In a general way, three-cylinder locomotives have a small hammer blow per axle, and for the engine as a whole, but are characterised by a high blow per wheel, which makes a reduction in the balanced percentage of the reciprocating weights most desirable, especially where the reciprocating balance cannot be spread over a number of wheels, as in four-coupled designs. In several of the most recent British locomotives advantage has been taken of the work of the Bridge Stress Committee, and low hammer blows per wheel, per axle, and for the engine are the result. Further, several classes of engine have been rebalanced in accordance with the findings of the Committee's investigations.

Best modern practice under British influence balances 25 to 40 per cent. of the reciprocating parts, but on the Continent modern passenger engines rarely have more than 25 per cent. balanced, and the proportion gets down as low as 10 per cent. Interesting figures as to the practice of Continental railways were given in THE ENGINEER, August 25th, 1933, page 177. The rules of the Japanese Government Railways for three-cylinder locomotives allow for a maximum hammer blow of 15 per cent. of the static load on each wheel at 60 m.p.h., which results in an average of only 20 per cent. of the reciprocating weights being balanced. Mr. Maunsell in his four-cylinder "Lord Nelson" class balances only 40 per cent. of the reciprocating weights with very satisfactory results—see THE ENGINEER, November 19th, 1926.

ARGENTINE 4–8–0 LOCOMOTIVE.

Several interesting points occur in the balancing of three-cylinder locomotives, and these are covered in the following calculations, which apply to the 4–8–0 engines of the Buenos Aires Great Southern Railway. Calculations to show the effect of reducing to one-third the balanced percentage of the reciprocating parts from the specified two-thirds are not included, as the reciprocating balance is spread over six coupled wheels, and the resulting hammer blow is very small. The effect of prolonging the inside webs of the crank axle in the form of a balanceweight is dealt with. In engines which are very close to the weight limit, a reduction in the weight and in the centrifugal force may be gained by hollow-boring the inside and outside crank pins.

TABLE II.—*Weight of Revolving Parts at Crank Radius (13in.).*

	lb.
1 inside connecting-rod (part), and included crank pin	520
1 outside connecting-rod (part), and included crank pin	328
2 crank axle inside webs (414 lb. at 10½in.)	322
1 coupling-rod portion with included pin (leading)	117
1 ,, ,, ,, (driving)	380
1 ,, ,, ,, (inter.)	222
1 ,, ,, ,, (trailing)	117
1 wheel crank boss with included pin (leading)	111
1 ,, ,, ,, (driving)	164
1 ,, ,, ,, (inter.)	111
1 ,, ,, ,, (trailing)	111
1 fly-crank (part)	29

This eight-coupled Argentine engine runs on the 5ft. 6in. gauge, has wheels of 4ft. 7½in. diameter, and cylinders 17½in. by 26in. The cylinders are not set at an angle of exactly 120 deg., the inside unit being inclined to the horizontal at 1 in 6½ and the outside pair at 1 in 15, giving angles of 120 deg., 125 deg. 17 min., and 114 deg. 43 min. This at once introduces a complication into the calculations in that the balanceweights on opposite sides will not be the same. The weights of the reciprocating parts are given in

TABLE III.—*Planes, Masses, and Moments, Driving Wheels.*

Plane number.	Distance, inches.	Mass at 13in. radius, lb.	Mass moment, lb.-ft.
1	−15·25	29	− 442
2	−11·25	328	− 3,690
3	− 5·0625	380	− 1,920
4	0	963	0
5	0·125	164	20
6	34·5	842	29,000
7	68·875	164	11,280
8	69·0	895	61,750
9	74·0625	380	28,100
10	80·25	328	26,300
11	84·25	29	2,440

Table I, and the weights of the revolving parts reduced to equivalent weights at a radius of 13in. (*i.e.*, the crank throw) are given in Table II.

The balance of the reciprocating parts is sometimes concentrated in the driving wheel, and sometimes spread equally over all the driving and coupled wheels, but in this 4–8–0 locomotive the small diameter of the wheels made it impracticable for the driving wheels to carry their share, and the amount required was therefore divided equally between the six coupled wheels. There is thus no hammer blow from the driving wheels. At the crank radius the weight is

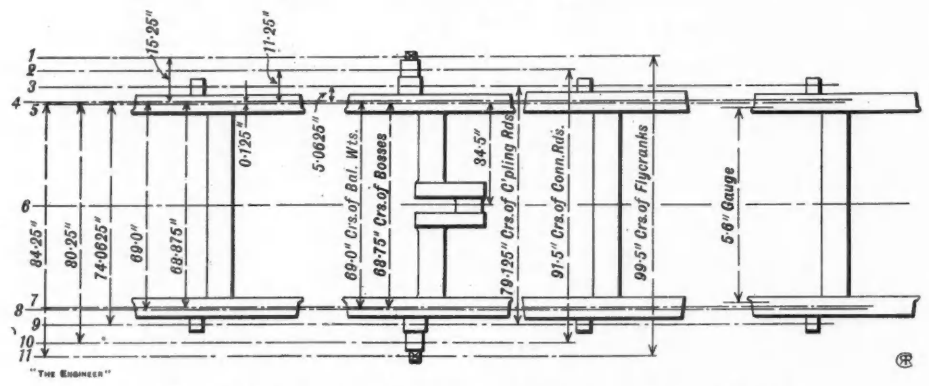


FIG. 1—BALANCING PLANES OF THREE-CYLINDER 4-8-0 ENGINE

560 lb. from the reciprocating weights of each outside cylinder, and 536 lb. from the inside cylinder, which is equivalent to 187 lb. per wheel from the outside cylinders and 178 lb. per axle from the inside cylinder.

Following the method originated by Professor Dalby, Fig. 1 is laid out to show the number and positions of the various planes in which weights are acting. The exact position of the reference plane,

TABLE IV.—*Planes, Masses, and Moments, Inter. Wheels.*

Plane number.	Distance, inches.	Mass at 13in. radius, lb.	Mass moment, lb.-ft.
2	−11·25	187	− 2,105
3	− 5·0625	222	− 1,122
4	0	551	0
5	0·125	111	14
6	34·5	178	6,140
7	68·875	111	7,650
8	69·0	551	38,000
9	74·0625	222	16,440
10	80·25	187	15,000

No. 4, is chosen from experience to represent a suitable transverse centre line for the balanceweight in the wheels. For each set of wheels the masses and mass moments are as given in Tables III, IV, and V respectively. The leading and trailing coupled wheels are the same, but the intermediate pair have slightly greater masses due to the halves of two sets

of coupling-rods and somewhat bigger outside crank pins.

The mass and mass moment (or couple) polygons must now be drawn out, as shown in Fig. 3. The couple polygon is drawn out first, and its closure gives the magnitude of the balanceweight required at the crank radius. The direction of the closure line gives the angle at which the balanceweight must lie in relation to the crank. In the mass polygon must be included a line parallel to the closure of the couple polygon and of a length equal to the balanceweight at the crank radius. The closure of the mass polygon gives the weight required at the crank radius for the wheel on the opposite side, and indicates the angle. The main point to watch in drawing the polygons is to give each item its appropriate sign, following the

TABLE V.—*Planes, Masses, and Moments, Leading and Trailing Wheels.*

Plane number.	Distance, inches.	Mass at 13in. radius, lb.	Mass moment, lb.-ft.
2	−11·25	187	− 2,105
3	− 5·0625	117	− 585
4	0	433	0
5	0·125	111	14
6	34·5	178	6,140
7	68·875	111	7,650
8	69·0	433	29,880
9	74·0625	117	8,660
10	80·25	187	15,000

sign in Tables III to V. The closure line always returns to the central point.

In the case under consideration, the asymmetrical lay-out of the cranks results in different weights being required for the right and left-hand wheels (see Table III, planes 4 and 8). As this amounts to only 68 lb. at crank radius and 49 lb. at the radius of the balanceweight itself, the weights in each wheel were actually made the same, but there are several classes of three-cylinder locomotives in which the difference in weights has been too great to make such a compromise desirable. In practice the centre line of the balanceweight (*i.e.*, its angle to the crank) is moved one or two degrees to the centre line of the nearest spoke or to the centre line of the space between two spokes, and in the present example the leading and trailing weights were moved 48 min. from the theoretical angle shown in Fig. 3, and the intermediate weights were moved 1 deg. 4 min. In slow-speed engines it is not uncommon for the weights to be moved 5 deg. or 6 deg.

HAMMER BLOW.

The locomotive (weight 86 tons) being of large size, it might be thought unnecessary to balance such a large percentage of the reciprocating weights as the two-thirds specified by the consulting engineers, but actually the hammer blows are so small that this consideration is of little moment, although probably it will be seen that the weight required at the crank radius (13in.) is 700 lb. in the right-hand wheel and 609 lb. in the left-hand wheel. The couple and mass polygons and the balanceweight positions are shown in Fig. 4. As the reciprocating balance is spread over the coupled wheels down each side, the required weight in each wheel is 700÷3=233 lb. for the right hand and 609÷3=203 lb. for the left hand.

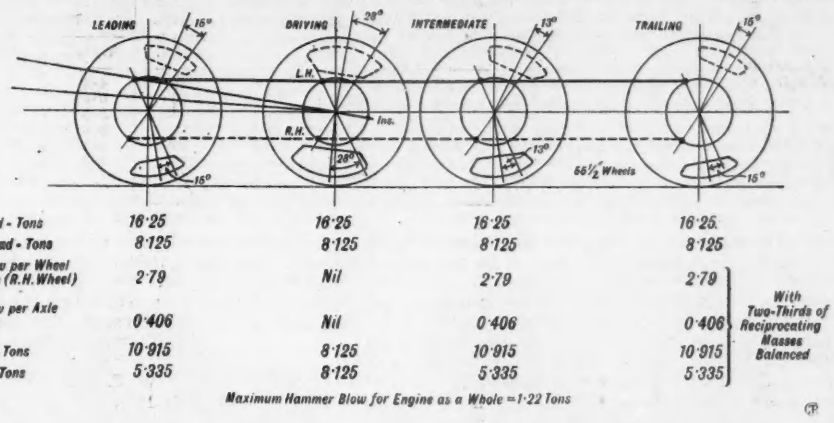

LEADING
DRIVING
INTERMEDIATE
TRAILING
15°
29°
13°
L.H.
Ins.
R.H.
28°
66½ Wheels
Nominal Axle Load - Tons 16·25 16·25 16·25 16·25
Nominal Wheel Load - Tons 8·125 8·125 8·125 8·125
Max. Hammer Blow per Wheel at 4·5 R.P.S., Tons (R.H. Wheel) 2·79 Nil 2·79 2·79
Max. Hammer Blow per Axle at 4·5 R.P.S., Tons 0·406 Nil 0·406 0·406
Max. Wheel Load - Tons 10·915 8·125 10·915 10·915
Min. Wheel Load - Tons 5·335 8·125 5·335 5·335
With Two-Thirds of Reciprocating Masses Balanced
Maximum Hammer Blow for Engine as a Whole = 1·22 Tons
"THE ENGINEER"

FIG. 2—HAMMER BLOWS AND POSITIONS OF BALANCE WEIGHTS. THREE-CYLINDER 4-8-0 LOCOMOTIVE

The angular positions of the balanceweights are the same as shown in Fig. 4 for the concentrated weight, the positions being located in the same phase by the coupling-rods. The angle between the right-hand and left-hand balanceweights is seen to be 176 deg. This is quite different to the angle between the actual balanceweights in the wheels as indicated in Fig. 3.

If L_1=the reciprocating balanceweight in the left-hand wheel (203 lb.) and R_1=the corresponding weight in the right-hand wheel (233 lb.), the resultant T_1 of these forces at the angle Q (176 deg.), as found by the parallelogram of forces, is 34 lb. The hammer blows are then as follow :—

A_L=Max. hammer blow from each left-hand wheel=$1·22\ L_1\ n^2\ r$ lb. . . . . (2)

A_R=Max. hammer blow from each right-hand wheel=$1·22\ R_1\ n^2\ r$ lb. . . . (3)

A_A=Max. hammer blow from each axle =$1·22\ T_1\ n^2\ r$ lb. . . . . (4)

in which

n=number of wheel revolutions per second (assumed at 4½ in these calculations),

r=crank radius in feet.

Putting in the required values, equations (2), (3), and (4) become

$A_L=1·22\times203\times4·5^2\times1·083=5450$ lb.
$=2·43$ tons.

$A_R=1·22\times233\times4·5^2\times1·083=6250$ lb.
$=2·79$ tons.

$A_A=1·22\times34\times4·5^2\times1·083=912$ lb.
$=0·406$ tons.

The resultant T_2 of the weights L_1, L_3, L_4, and R_1, R_3, and R_4 down each side, obtained from the parallelogram of forces, is 102 lb., and the maximum hammer blow from the engine as a whole, A_E, is equivalent to $1·22\ T_2\ n^2\ r$ lb., which is

$A_E=1·22\times102\times4·5^2\times1·083=2730$ lb. or
1·22 tons.

If the angle Q had been 180 deg., as it would had the cylinder spacing been equal, A_E would have been zero, and from the bridge stress point of view this would have been a decided advantage, although the hammer blow of each wheel still causes rail stress and a certain amount of torsional oscillation in the bridge members.

With any excess balance there is a certain speed at which the wheel will lift from the rail, but as a general rule this is well outside the possible range. This critical speed is given by

$$V=\frac{D^2\ W}{0·00012\ m\ r} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

in which

D=wheel diameter in feet.
W=Static axle load in tons.
m=Balanceweight for reciprocating parts in lb.
r=Radius of balanceweight in feet.

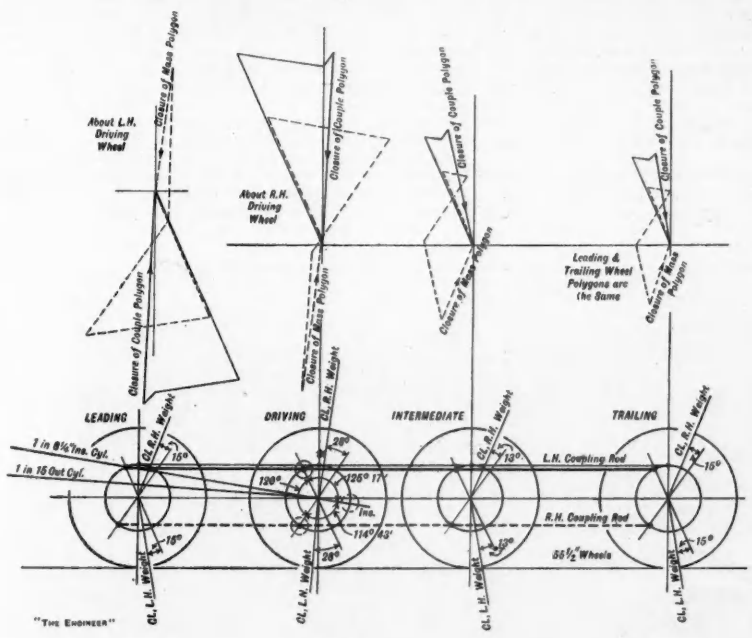


FIG. 3

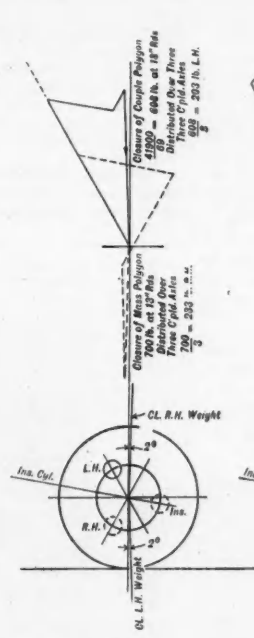


FIG. 4

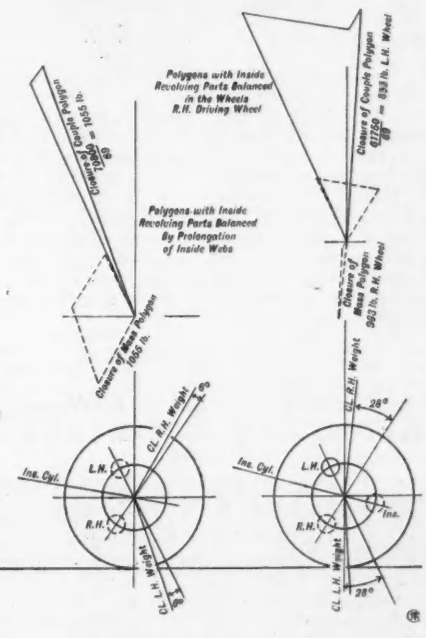

Polygons with Inside Revolving Parts Balanced in the Wheels R.H. Driving Wheel
Polygons with Inside Revolving Parts Balanced By Prolongation of Inside Webs
Closure of Couple Polygon
Closure of Mass Polygon
Cl. R.H. Weight
Cl. L.H. Weight
L.H.
R.H.
Ins. Cyl.
Ins.

FIG. 5

In the Argentine 4–8–0 locomotive the value of V is

$$\frac{4·6^2\times16·25}{0·00012\times218\times1·083}=111 \text{ m.p.h.}$$

The figure 218 lb. is simply an average, taken for convenience, between the 203 lb. and 233 lb. of the left and right-hand balanceweights. If the whole of the two-thirds reciprocating weight had been balanced in the driving wheels alone, the critical speed would have been 63·5 m.p.h. These calculations assume that the revolving parts are completely balanced. From all the foregoing calculations, it will be seen that although a large percentage of the reciprocating weight is taken into account, this B.A.G.S.R. 4–8–0 locomotive is a very well balanced machine. In Table VII are given hammer blow values for a number of three-cylinder locomotives, most of which have been culled from the report of the Bridge Stress Committee.

BALANCING THE INSIDE MASSES.

Contrary to what might be expected at first sight, the size of the balanceweights in the driving wheels (where all three cylinders drive on one axle) is not reduced by prolonging the inside crank webs to form a balanceweight for the webs, pin, and revolving portion of the inside connecting-rod. This method, however, may have some advantage by balancing the above masses in their own plane and eliminating the bending stress in the axle due to the rotation of the inside parts.

Consider, again, the 4–8–0 locomotive of the B.A.G.S.R., and assume that the 842 lb. (at crank

TABLE VI.—*Planes, Masses, and Moments, Reciprocating Weights (for Equivalent Driving Wheel).*

Plane number.	Distance, inches.	Mass at 13in. radius, lb.	Mass moment, lb.-ft.
2	−11·25	560	− 6,400
4	0	700	0
6	34·5	536	18,220
8	69·0	609	41,900
10	80·25	560	44,900

a somewhat less proportion would not affect the riding qualities of the engine.

In order to obtain the hammer blows, it is necessary to separate the balanceweight into its reciprocating and revolving components. The reciprocating masses to be balanced are 0·66×839 lb.=560 lb. per outside cylinder and 0·66×803 lb.=536 lb. for the inside cylinder. Taking these as being concentrated in one pair of wheels, the planes (corresponding to the required numbers in Fig. 1), masses, and moments are as shown in Table VI. From this table

radius) of the inside webs, crank pin, and connecting-rod portion can be completely balanced by prolongation of the webs. Then from Table III, plane No. 6, can be cancelled out and the couple and mass polygons drawn up from the remaining items. The engine may now be considered as a two-cylinder unit, but with cranks at 120 deg., and the balanceweights in each of the driving wheels are equal, and almost opposite to their respective cranks. But the partial balancing effect of the inside masses is absent, and the required weight is thus increased to 1055 lb. in each wheel from 963 lb. in the right-hand wheel and 895 lb. in the left-hand wheel of the original arrangement. The couple and mass polygons for prolonged and normal inside webs are shown side by side in Fig. 5, and the figures for the various planes of the prolonged web lay-out are given in Table VIII. The polygons referring to the normal arrangement in Fig. 5 are for the right-hand driving wheel.

TABLE VII.—*Hammer Blows of Various Three-cylinder Locomotives.*

Railway.	Type.	Class.	Wheel dia., inches.	Axle load, tons.	Speed at 6 r.p.s., m.p.h.	Hammer blow, tons, Wheel.	Axle.	Engine.
L.N.E.R.	4–6–2	A1	80	22·05	86	4·3	2·6	2·3
	4–6–2	A2	82	20·0	88	0·82	1·03	1·25
	2–6–0	K3	68	20·0	73	5·0	3·5	1·9
	0–8–0	Q7	55	19·0	59	3·69	1·15	0·95
L.M.S.R.	4–6–0	6100	81	20·9	87	4·2	0·3	0·9
Southern	2–6–0	N1	66	18·5	71	2·9	2·7	1·6
B.A.G.S.R.	4–8–0	11C	55	16·25	59	4·9	0·72	2·16

TABLE VIII.—*Planes, Masses, and Moments, Prolonged Web Balancing.*

Plane number.	Distance, inches.	Mass at 13in. radius, lb.	Mass moment, lb.-ft.
1	15·25	29	— 442
2	11·25	328	— 3,690
3	5·0625	380	— 1,920
4	0	1,055	0
5	0·125	164	20
7	68·875	164	11,280
8	69·0	1,055	70,800
9	74·0625	380	28,100
10	80·25	328	26,300
11	84·25	29	2,440

No change in the method of balancing the reciprocating parts has been assumed. If the driving axle were to carry its share of this balancing by an addition to the web prolongation the bending stress in the axle due to the rotation of the parts concentrated on the inside crank pin would not be eliminated. If the reciprocating balance was put in the driving wheels, the hammer blow of the coupled wheels would be reduced and hammer blow given to the driving wheels. The stipulated 16·25 tons axle load would also be exceeded for the driving axle, but this would be of small moment, as it is subservient to the effect of the hammer blow.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SIGNALMEN'S MISTAKES.

SIR,—We have read with much interest the article on track circuit and automatic train control in your issue of July 12th.

In view of the serious consequences of the mistakes made by signalmen, not only in the accidents which have occurred recently, but in those to which you also referred, we desire to point out that while track circuit, if provided everywhere, would very largely eliminate the human element as regards the signalman, nevertheless blunders of the kind in question can be effectually met by means of a good lock-and-block system properly installed.

On the suburban lines of the former Great Eastern Railway such apparatus has been in general use ever since about 1897, and it can be safely asserted that not one of the accidents you discuss would have occurred had it been in existence on the sections of the line concerned. It does not appear to be sufficiently realised that these accidents were all caused, not by deliberate neglect, but by momentary misunderstanding on the part of the signalman—at least to begin with—who was able, without any mechanical check on his actions, to defeat the whole object of the block system in a few moments.

With the apparatus to which we refer, the signalman cannot be under any misapprehension as to whether a train has or has not reached him, nor can he operate his block instruments for a second train until he has gone through all the necessary movements, both with signals and block instruments, to send the previous one forward. Thus, for example, the unfortunate signalman at Winwick Junction would have been powerless to commit his disastrous mistake because he had not yet worked any signals to dispose of the rail motor train.

Although the lock-and-block apparatus most in use in this country happens to be of our make, we wish to say that other, and very good, forms exist, and have been used for years, especially abroad, such as the Siemens and Halske in German-speaking countries and the Lartigue electro-semaphore block of the Chemin de fer du Nord. On the German State Railway, for instance, such apparatus is compulsory wherever more than four trains in an hour can run, and is used widely even where that condition does not obtain. We have found Continental signal engineers astounded at the way in which so many of our main line sections are worked, with nothing to check the commission of errors such as have led to the King's Langley and Welwyn accidents. It is worth while remembering that the first-named would have had the most dreadful results had not all four trains, by great good fortune, been freight trains. The number of casualties in an accident, however, has little or nothing to do with the error which gave rise to it, the gravity of which should be judged on its merits and steps taken accordingly.

W. R. SYKES INTERLOCKING SIGNAL COMPANY, LTD.,
F. J. SYKES, Managing Director.

London, S.W.4, July 19th.

Electrification on the Hungarian State Railways.

ON account of the unusual features of the Kando system that has been adopted, the electrification of the Hungarian State Railways has aroused great interest. It was described in our issues of January 6th and 13th, 1933, and our electrical readers will no doubt remember that it differs from other systems, in that the trains are operated with 50-cycle single-phase current. As the working pressure is 16,000 volts, the static sub-stations are widely spaced and operating costs on the distribution side of the system are naturally low. Single-phase current is derived from the national grid system working at the standard frequency of 50 cycles. The single-phase railway load is distributed over the three phases and, despite the fears that some engineers seem to have had regarding the unbalancing of the system, experience has shown that the power and lighting consumers have no grounds for complaint.

The original contracts for the scheme were placed in 1931, when the Metropolitan-Vickers Electrical Company received the order for the supply and erection of the four static transformer sub-stations. The same company also acted as sub-contractors to Ganz and Co., of Budapest, for the manufacture and supply of pantographs, control equipments, and thirty 2500 h.p. main traction motors, including four spares for twenty-six locomotives. Work on the sub-stations and on two passenger and goods locomotives was put in hand immediately. The first passenger engine began its trials on May 6th, 1932. It was finished off and put into intermittent service on August 22nd and into regular passenger service on September 12th. Within twelve months from the latter date it had run 86,048 miles. The second passenger locomotive began its trials on June 17th, 1932, and the two goods locomotives followed in quick succession. Satisfactory results having been obtained from the service tests on the first four locomotives, work on the remaining twenty-two was begun in April, 1933, and completed in the same month of 1935.

The goods locomotives were designed to haul at reduced speeds considerably heavier trains than those for passenger service, but after experience it was decided that the remaining twenty-two locomotives should all be of the passenger type, the weight of goods trains being reduced correspondingly in weight. Up to May, 1935, the performance was as follows :—

Passenger locomotive No. V40,001	171,000 miles
Passenger locomotive No. V40,002	205,500 miles
Goods locomotive No. V60,001	90,700 miles
Goods locomotive No. V60,002	65,200 miles
Total performance of the twenty-six locomotives	1;300,000 miles

The monthly performance of the locomotives in service varies between 6830 and 8070 miles, depending on the time table, these figures including the fast trains and to a large extent the slow goods trains stopping at every station. Apart from a few local trains, all the traffic on the entire Budapest-Hegyeshalom line is now hauled electrically and the advantages of electric traction are said to be greatly appreciated by the passengers and railway authorities alike. The adoption of a single type of locomotive for all kinds of service has been found to be very helpful in the making up of time tables and in other ways. Even under the care of comparatively untrained men the locomotives have proved to be very reliable. The phase changers and automatic regulators are said to have worked perfectly. On one of the locomotives which has completed 205,500 miles of interrupted service the phase converter, which is usually regarded as the most complicated part, has worked without giving the slightest trouble and without maintenance. Any desired intermediate speed on the three-phase motor can be obtained without difficulty.

Although the synchronous speed of the fourth stage is 62·1 m. per hour, the speed between Gyor and Hegyeshalom is limited to 52·8 m.p.h. by simple adjustment of the acceleration lever, and it remains practically unchanged. In short, the whole of the scheme, including the overhead lines and sub-station, is giving complete satisfaction and the highest expectations have been realised.

A passenger locomotive hauling a 600-ton train on the Hungarian State system is shown in the accompanying illustration.

HUNGARIAN STATE RAILWAYS 600-TON PASSENGER TRAIN

AMERICAN LOCOMOTIVE REPAIR SHOPS.

WITH about 22 per cent. of the locomotives and 15 per cent. of the freight cars on American railways reported as requiring repairs, while normally these figures should not exceed 14 and 4 per cent. respectively, attention is drawn to the situation as regards the railway repair shops. More than 25 per cent. of the annual working expenses go for maintenance of rolling stock, which means about £80,000,000 in normal years. The investment in machinery is some £64,000,000, but nearly 70 per cent. of this machinery is old or obsolete, according to a recent survey, and manifestly it is not economical to purchase new locomotives whose maintenance must be handled under such shop conditions. The railways have been backward in this respect for many years, long before the present period of depression. In fact, in twenty years the expenditure on shop equipment has been only about 4 per cent. of all the money spent on improvements. This is the average, although there are striking exceptions, of course. There are about 400 locomotive repair shops, 3270 running sheds, and 568 carriage and wagon repair shops. They are valued at £199,000,000, of which 66 per cent. is for the shops and engine-houses and 34 per cent. for machinery. The average age is twenty-one years, but in twenty-one years the tractive power of locomotives and consequently their weight has increased nearly 50 per cent., and their length has more than doubled, thus increasing the difficulty of handling them in old shops and engine-houses or running sheds. There is obvious need of a definite policy for the replacement of obsolete locomotives, cars, and repair shop equipment over a term of years. The railways as a whole have not built up any depreciation fund as a reserve for purchasing new tools, but have purchased them at haphazard, and with regard to individual shops rather than to the shops and shop equipment as a unit. Modern machine tools, as compared with those twenty to forty years old, can effect substantial economies and may often pay for themselves in a relatively short time. Unfortunately, the time is not favourable for the consideration or adoption of a better system or policy.

A Visit to the B.T.H. Works.

LAST week a party of about 100 members of the Association of Mining Electrical Engineers visited the Rugby works of the British Thomson-Houston Company in connection with the Association's Annual Convention that was being held in Nottingham. That the heavy electrical manufacturing business is in a better condition than it was a little time ago was made clear by the appearance of the shops, which are at present fairly busy. Many of the departments were inspected, and as is not unusual on the occasion of such visits to Rugby, an experimental lecture was delivered by a member of the company's staff. The lecturer was Mr. L. J. Davies, of the research laboratory, who dealt with "B.T.H. Research Work, with Special Reference to Electric Lighting." Ingeniously devised discharge lamp demonstrations were given, and attention was called to the effect which lamp research has had on the development of other things, such as thermionic valves, photo-electric cells, and thyratrons. The cathode ray oscillograph, which is perhaps rather less familiar to mining electrical engineers than it is to many others, was demonstrated. Like other lectures or talks that have been given when institutions and associations have visited these works, this short, but informative lecture by Mr. Davies was highly appreciated.

During the tour of the shops, the party found electrical mining equipment, both in the course of manufacture and complete. Among the most interesting items was a portable mining sub-station, composed of a small transformer with circuit breakers at both ends. Other electrical mining equipments consisted of heavy-duty, slip-ring motors for haulages; general-purpose mining motors, both for use on the surface and underground; oil-immersed high-tension contactor and drum controllers with unbreakable flameproof and non-flameproof resistance for underground and surface haulage motors; hand-operated and contactor type air break and oil-immersed starting and control gear; flameproof motors; gate end boxes; small lighting transformers for coal face use in mechanised mining; and ironclad draw-out switchgear for mining and general industrial use. Examples of some of the mining equipments seen are shown in Figs. 1 to 3. The first is a flameproof ironclad draw-out switch unit, with earth leakage equipment, circuit and bus-bar terminals and sealing boxes. The second is a 5-kVA flameproof transformer which, like the switch unit, complies with official requirements; whilst the third picture shows a Ward Leonard controller for electric winder service, the end covers being removed to show the internal arrangement.

Some of the jobs in hand are associated with important contracts obtained from abroad and represent substantial sums of money. Among the electric winder equipments to be seen in the course of manufacture were two Ward Leonard sets for Van-Dyk Consolidated Mines, Ltd. One is for driving a rock hoist and the other a man hoist. The driving motor for the former is a 1850 h.p. 54·6 r.p.m., 600-volt, shunt-wound machine, designed for winding 161 tons of rock per hour. That for driving the man hoist is rated at 1700 h.p. at 57 r.p.m., and is also designed for operation at 600 volts. These winder motors are shown in Fig. 4. Both winders are for winding from a depth of 3600ft., and the man hoist will deal with 85 tons per hour. Power for the motors is to be obtained from motor generator sets, and one (Fig. 5) has a 20-ton fly-wheel, capable of maintaining power on the winder by giving up its stored kinetic energy as it falls in speed. A Ward Leonard Illgner winder equipment nearing completion is for New Zealand. Its motor is rated at 320 h.p. at 600 r.p.m. Arranged for fly-wheel equalisation, the motor generator for this equipment has a 6-ton fly-wheel and a commutator type slip regulator, which serves, in addition, for power factor correction. Three other electric winding equipments in hand are for the East Rand Proprietary Mines. Two are 1110 h.p., 368 r.p.m., A.C. sets; and the third a Ward Leonard set rated at 935 h.p., with an unequalised motor generator having two exciters to take care of emergency regenerative braking.

Apart from the mining contracts being dealt with, one of the most interesting jobs in hand is the construction of some regenerative mercury arc rectifiers, forming part of an order for twenty sets for the South African Railways. Received from the Electricity Supply Commission through Wilson and Herd, Ltd., the order is said to be the largest so far placed for mercury arc rectifiers, capable of inverted operation. Grid control is to be employed, both for conversion from D.C. to A.C. and for maintaining the voltage of the sub-stations constant under varying load conditions. Transformers for use in conjunction with these rectifiers were in evidence. Needless to say, they are of special design and rather more complicated than orthodox transformers. We believe that these rectifier equipments with special transformers are the first of the kind to be built in this country for commercial use, and they serve to show that British manufactures are keeping abreast of the times. The use of rectifiers on railways operating under conditions that make regeneration desirable was at one time impossible. But since the advent of grid control, the situation has been changed and although it is improbable that there will ever be a big demand for rectifiers capable of changing D.C. into A.C. on railway systems in this country, it is satisfactory to find that this important application of rectifiers has not been overlooked by British manufacturers. Firms other than the B.T.H. Company have brought experimental inverted rectifiers to our notice, but last week was the first occasion on which we have seen a number of such rectifiers being manufactured to order. The contract mentioned includes a large number of high-speed track circuit breakers similar to those at present used on the existing 3000-volt electrified section of the South African Railways.

Although the company's turbine department has turned out many turbo-alternators and compressors for colliery service, little plant of this nature was to be seen last week. Large turbo-generator sets for use in power stations were, however, in evidence, including a 50,000-kilowatt set for the Ironbridge station of the West Midlands Joint Electricity Authority. As our readers are aware, the alternator of this set is to work at 33 kV and on account of transport difficulties the work of winding the stator is to be carried out on site. That the demand for alternators working at this pressure is increasing was indicated by the presence of another 33-kV, 50,000-kW machine for the Kearsley power station of the Lancashire Electric Power Company. Parts of a 30,000-kW turbo-alternator, being built to the order of Balfour, Beatty and Co., Ltd., for installation in the Spondon power station of the Derby and Notts. Electric Power Company, were also to be seen. Among other machines were two coke oven gas exhausters, ordered by Woodall, Duckham, Ltd., for the United Steel Corporation. Each exhauster has an output of 900,000 cubic feet per minute, when discharging against a maximum pressure of 3½ lb. per square inch gauge, and it runs at a maximum speed of 6000 r.p.m. The turbine is a single-stage machine designed to exhaust against a back pressure of 15 lb. per square inch gauge, whilst the exhauster is a two-stage machine. Despite the efforts that are being made to discourage the practice of generating electricity privately, several sets were being manufactured for industrial use.

Besides the transformers mentioned, there were many others under construction in the transformer shops, including some specially designed units for use in conjunction with a new plant for testing heavy-duty circuit breakers. Although the largest unit being constructed is rated at 45,000 kVA, transformers up to 60,000 kVA have been built at Rugby. Among the mining transformers were four forming part of an order for a colliery in the Midlands. Two for surface installations are rated at

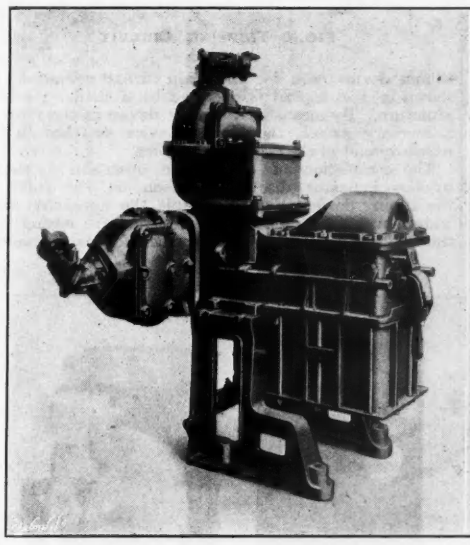


FIG. 1—IRONCLAD SWITCH UNIT

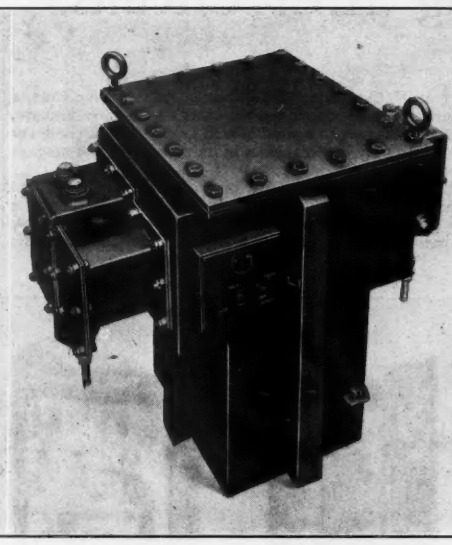


FIG. 2—FLAMEPROOF TRANSFORMER

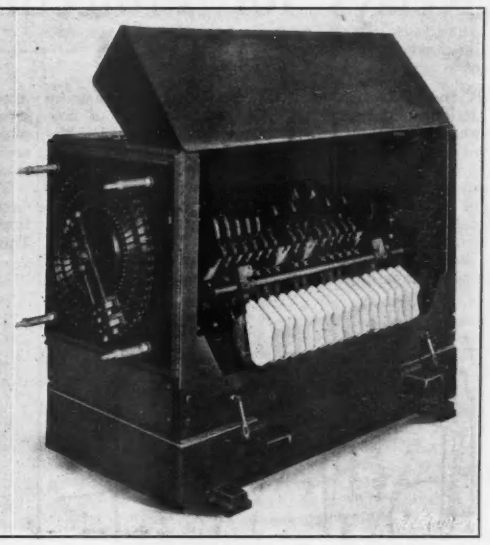


FIG. 3—WARD-LEONARD CONTROLLER

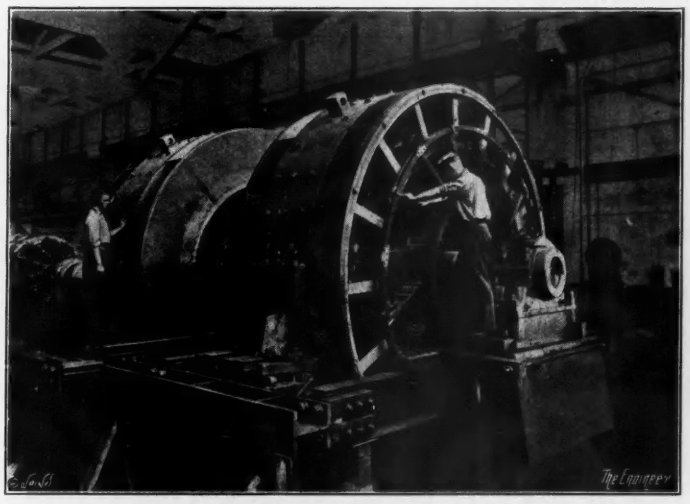


FIG. 4—WARD-LEONARD WINDER MOTORS

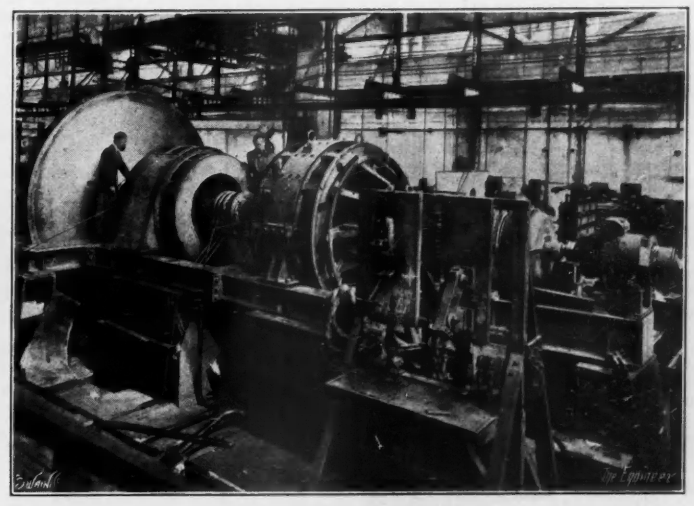


FIG. 5—MOTOR GENERATOR SET

600 kVA and 150 kVA, and two of small dimensions for use underground at 250 and 150 kVA. There were many instrument transformers.

Electric motors suitable for all kinds of service were to be seen. Among the company's special motors was the no-lag machine, capable of performing every duty within the scope of an ordinary inductor motor, and of running at any desired power factor. In mines and quarries "No-Lag" motors are particularly suitable for driving haulages and crushers which are subject to fluctuating overloads, and can raise the power factor of a system on which ordinary induction motors are also employed. The B.T.H. variable-speed shunt characteristic A.C. motor, first introduced in 1916, was on view.

In the large three-storey control gear factory the visitors witnessed the manufacture of starting and control gear for industrial mining and traction purposes. Large contactor panels were being made for the control of electric drives for coal-washing plant and sectional paper machine drives. Standard products under construction were hand-operated and automatic starting gear for A.C. and D.C. motors, ranging from fractional horse-power units up to equipments for controlling large machines for rolling mills and ship propulsion. Two sets of high-tension A.C. air break reversing contactors for electric winder service were representative of many of these equipments that have been supplied for controlling electric winders up to 2160 h.p.

Other departments visited were those devoted to the production of domestic appliances, such as refrigerators, cookers, washing and ironing machines, the lamp factory and the research laboratory, which serves to guide the whole factory in the development and production of the many classes of electrical goods the company supplies. The party was entertained to lunch and tea, and the visit was greatly appreciated by all present.

Relays for Protecting A.C. Circuits.

FOR the protection of A.C. distribution systems the Oerlikon Company has introduced a series of new relays capable of meeting various requirements. When the system expands radially or spreads in tree-shaped fashion, selective protection can be ensured by employing maximum current relays with the timing scaled down from the power station to the furthest part of the system. The scheme that calls for the smallest capital outlay is that in which the relays are inserted directly in the H.T. line and, therefore, carry the main current, the best arrangement being to fit the relays directly on the terminals of the circuit

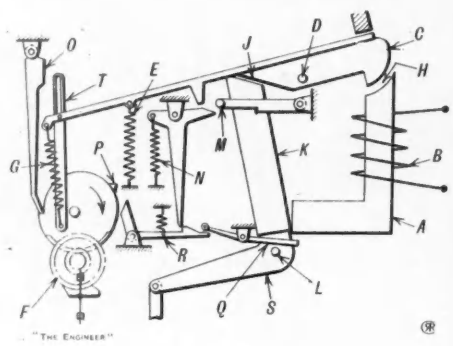


FIG. 1—DETAILS OF RELEASE DEVICE

breakers they control. The circuit breakers are then directly released by an isolation rod. As these relays actually cause the release of the circuit breakers without relay action, it is more correct to describe them as release devices. Such devices have to meet several requirements. When the current reaches a certain predetermined value, they have to bring the timing device into play and ensure that under all conditions release takes place after a predetermined time lag. Finally, they must be capable of mechanically releasing the circuit breaker at the end of that time. In certain cases, in the event of a short circuit,

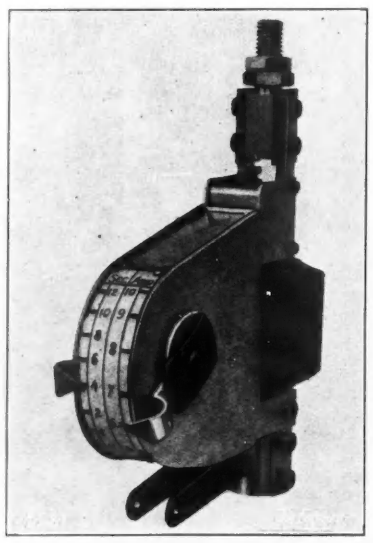
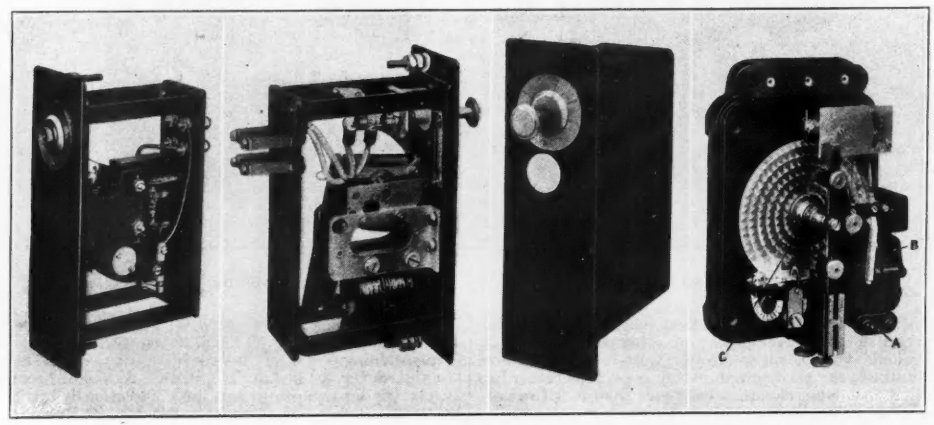


FIG. 2—RELEASE DEVICE

current exceeding a certain value, such as three times the normal current, the release must take place instantaneously.

The new Oerlikon main current release device has a single magnet circuit and two armatures are linked in series. The fixed part of the solenoid A (Fig. 1) carries the main current winding B, and the first armature C, which can move about the pivot D, is attracted when the current limit is exceeded. It also operates the timing device. By adjusting the tension on the spring E, the current setting is fixed, while the timing device, which consists of a precision armature F, is operated through the intermediary of a spring G. When the armature C is attracted the air gap H is closed. At the same time, a second air gap J is opened at the other end of the armature, which is designed as a double-arm lever. When the lever comes into play the variation in inductance of the magnet is kept small.

The second armature K, pivoted at L, releases the circuit breaker, but is held back by a catch M until the time for which the timing device has been set expires. The catch M is then released with the aid of the spring N, which is again put in tension when the relay is brought back to its initial position by the strong spring E. The timing device F only begins to run out when the current limit armature C has been fully attracted and has freed the timing device by disengaging the catch O. The timing device always runs out with the spring under the same tension, and as it is reset in its initial position by means of the small rod T, when the armature drops back with all the play eliminated, the time setting is kept perfectly accurate at all values of the short circuit current.



FIGS. 3 TO 6—PIVOTED ARMATURE RELAY, TIMING UNIT, AND DISC RELAY

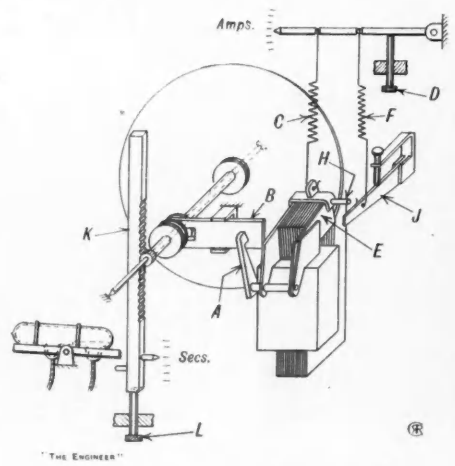


FIG. 7—DETAILS OF DISC RELAY

Besides the two main armatures there is a small lever Q, which serves as an auxiliary armature, and in the event of a given short circuit current being exceeded, brings the storage device into play for freeing the release armature by hitting the catch R, which can be locked or freed by a clamp according to the working conditions, the mechanical release of the corresponding circuit breaker taking place by impact. In the case of the Oerlikon main current release device, the lever S connected to the release rod exerts an effort in an upward direction. An idea of the appearance of the release device can be gained from Fig. 2. The current and timing can be adjusted by means of an insulated hook while the device is under pressure.

For some years the Oerlikon Company has supplied a simple maximum current relay with a pivoted armature for maximum current protection where there is a control circuit battery. In the case of two-pole and independent maximum-current protection of a three-phase line, two current units (Fig. 3) are required, and a common timing unit (Figs. 4 and 5) for times up to twelve seconds. The current setting in the case of the current unit and the time setting in the case of the timing unit can be adjusted from the front by means of the key. The current unit has a strong metal contact designed for double interruption, and serves for switching on the timing unit. The timing device of the timing unit is identical to the precision armature

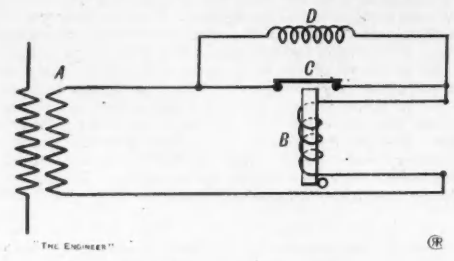


FIG. 8—TRIPPING CIRCUIT

timing device used for the main current release device shown in Fig. 1, and is operated by a similar pivoting armature. By means of a contact device in the form of a mercury switch the timing device switches on the release circuit of the oil circuit breaker.

The completion of the release operation is shown by the indicator disc to be seen on the front of the timing device (Fig. 5). While the apparatus illustrated in Figs. 3, 4 and 5 is designed for letting into the switchboard, it is also supplied for panel mounting. The power consumption of the current unit only amounts to 7 VA, and can be reduced to half that value if special bearings are fitted, as when the relay is used as a differential unit. The relay with pivoted armature (Fig. 3) is used both as a maximum and minimum relay for the control of current and pressure, while the timing unit is utilised as an independent timing relay.

Relays with timing dependent upon the current are

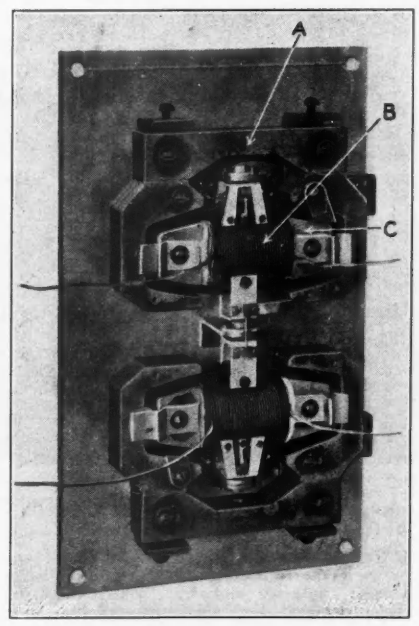


FIG. 9—DIRECTIONAL RELAY

used with advantage in front of individual current-consuming machines, such as large motors, when it is desired to trip circuit breakers as quickly as possible in the event of a short circuit, and by making a few additions the Oerlikon disc type relay (Fig. 6) has been converted into a dependent maximum current relay, which satisfies all modern requirements. By providing an operating solenoid A and a pivoted armature B, which couples the contact device with the Ferraris disc through the coupling

C, this relay has been made to work with a degree of accuracy of ±1 per cent. This is done by the single lever arm A and fork B (Fig. 7). When the current drops below the normal value, the contact device is immediately uncoupled and drops back into the zero position and over-running of the relay is prevented. The current setting is adjusted by varying the tension of the spring C by means of the screw D. To improve the ratio between the current at which the armature is released, and that at which it is attracted, shortly before reaching the drawn-down position, the armature E operates the additional spring F, through the intermediary of the pin H and the lever J. This spring is put under tension at the same time as the spring C.

The Ferraris disc begins to turn only after the current for which the instrument has been set has been exceeded. In this respect it differs from other designs in which the

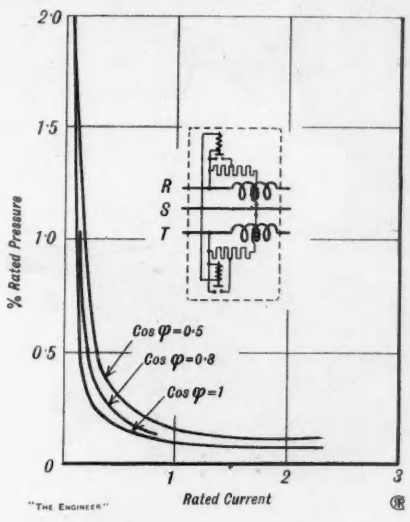


FIG. 10—CURRENT PRESSURE CURVES

disc begins to revolve when the current is a fraction of the normal current, and is coupled with the contact device by means of a special operating solenoid. Apart from being simple, the improved relay thus presents the advantage of having no parts permanently in motion, such as are liable to give rise to wear. The timing is done by adjusting the initial position of the small rack K by means of the screw L. For a current as low as three times normal current, the release times of the relay are practically independent of the value of the current. The degree of accuracy of the relay as regards timing is exceptionally great. It is about 0·02 second in the part of the curve where the time is dependent on the current, and about 0·01 second where the time is independent of it.

In this relay, which consumes only 10 kV, the contact device also takes the form of a mercury switch. As the relay is generally used where there is no control circuit

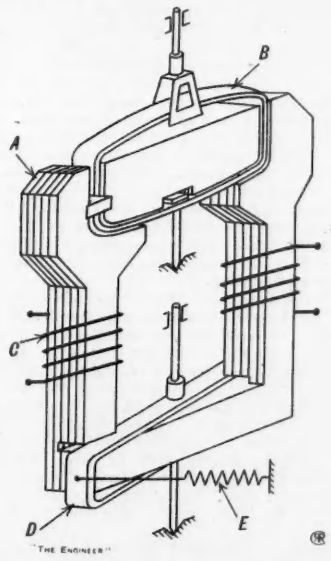


FIG. 11—DETAILS OF MAXIMUM CURRENT AND DIRECTIONAL RELAY

battery, "current transformer release" is adopted. Under normal conditions, the secondary of a current transformer A (Fig. 8) is closed through the relay winding B, by means of the contact device C. When the relay begins to run out as the result of an overload, it opens the contact C and inserts the secondary of the transformer in circuit with the tripping coil D of the oil circuit breaker, which is therefore released.

There are many protection schemes, such as those for parallel lines, that necessitate the use of power direction relays or wattmeter relays, and the Oerlikon Company has therefore evolved a highly sensitive wattmeter relay which can also be used for protection against earths. The iron core A (Fig. 9) embraces to a large extent the revolving system which carries the fine wire pressure system. The stationary current coil B is wound on the iron core C. The mechanical counter torque opposing the electrical torque of the revolving coil is provided by two spiral springs which also serve for carrying the current. To ensure a high degree of sensitiveness the coil frame and the supporting yoke are made of aluminium. The spindles run in semi-jewel bearings, and the revolving system is made proof against shocks by a liquid damping device. According to the number of poles, two or three measuring systems are used. With the object of increasing the switching capacity, a small auxiliary contactor is provided behind the base plate, whilst to increase the sensitiveness of the relay at low pressures, part of the resistance of the pressure coil is short-circuited at about 30 volts by means of a second small auxiliary contactor. At rated current and unity power factor, the instrument indicates the direction of power and operates with a very low voltage in the pressure path. The curves (Fig. 10) show the way in which the pressure that brings the relay into operation varies with the current in the current coil. In the pressure path the power consumption is 30 VA and in the current path 15 VA at rated pressure and current.

By making a small alteration to the solenoid core, the watt meter can be combined with a current relay. The upper part of the solenoid core A (Fig. 11), and the revolving system B, have been designed on the same lines as those of the corresponding parts of the power relay. The opening of the iron core is, however, enlarged in a down-

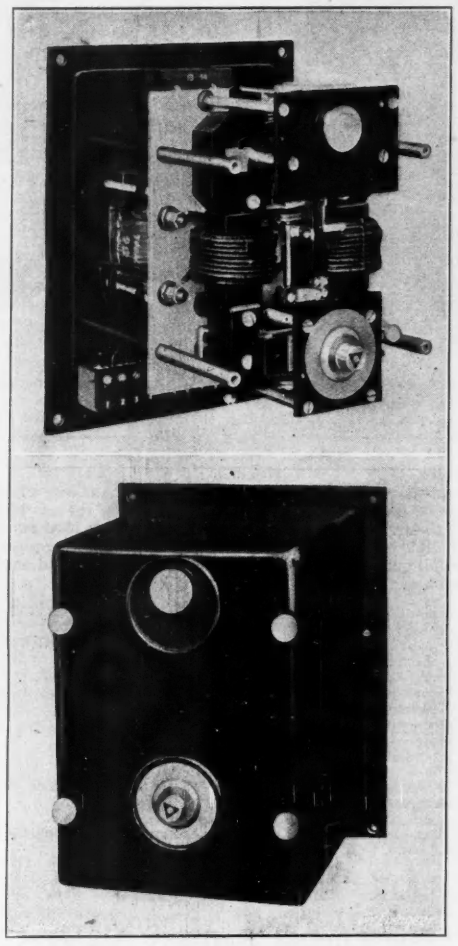


FIG. 12—MAXIMUM CURRENT AND DIRECTIONAL RELAY

ward direction, so that the current winding C can be placed on the two vertical limbs. A short-circuited revolving coil D is arranged over the lower yoke of the iron core. The transmission to the revolving coil of current, proportional to the current transformer current flowing in C, takes place by transformer action by means of the flux of the coil C flowing through the iron yoke. The torque of the revolving coil D is proportional to the square of the current, and is taken by the spring E which is adjusted according to the value of the current at which the relay is to operate. A combined maximum current and power direction relay is shown in Fig. 12. The current setting is adjusted by a disc as in the relays previously described. When the auxiliary contactor closes its contacts and thereby causes the circuit breaker to open, it releases the indicator disc above the current setting disc. This sensitive power direction relay is used for various protection schemes and for the protection of parallel units in particular.

The Hydrogenation-Cracking of Tars.

WITH the publication of two reports* dealing with the conversion of tars into motor spirit, the Department of Scientific and Industrial Research offers a substantial contribution to an economic problem of considerable national importance. A consideration of the statistics of production shows that the commercial value of the 2 million tons of tar produced annually fluctuates widely according to local conditions and demand, and it is obvious that some means of stabilising the position would be advantageous. The development of the so-called "low-temperature" carbonisation of coal is providing a still further supply of tars whose products, if complying with existing specifications, can be disposed of through the same channels as gas and coke-oven tars, although, in view of these added supplies, extended outlets are even more desirable.

A very promising line of attack on this problem appears to be the production of fuel oil and motor spirit from the tar through the action of hydrogen at high temperatures and pressures. This process has been actively investigated at the Fuel Research Station for some years. In the process the hydrogen probably combines with the molecules of substances already present in the tar. Some of these molecules are very complicated, and when combined with hydrogen are unstable under the conditions of heat and pressure. Consequently, they break up or "crack" into the smaller molecules of hydro-carbon, including those suitable for use as motor spirit and fuel oil. Hence the name "hydrogenation-cracking" has been given to the process. In practice the process is carried out in the presence of a catalyst.

The first of the papers recently issued deals with early exploratory work. It was decided in the first place to limit the work to small-scale experiments, using converters of 2-litre capacity and to restrict attention to low-temperature tar. It was to be expected that the results obtained would be dependent on such factors as the temperature and pressure in the reaction vessel, the duration of the period of reaction, the possibility of catalytic action and the nature of the tar itself. Several series of experiments were therefore planned in each of which certain factors were varied and the remainder left constant. The first series aimed at determining the best possible conditions in the converters. The results showed that a hydrogen pressure of 100 atms., a temperature of 450 deg. Cent., and a reaction period of two hours gave the best results. In the second series these conditions were adopted and the effect of a wide variety of catalysts was tried. The general conclusion is that a mixture of commercial molybdic acid and sulphur was the most effective substance.

Attention was then turned to varying the tar used as a raw material, maintaining the conditions as before. The tars were obtained from different low-temperature carbonisation processes, from five coals of different types carbonised in vertical cast iron retorts, and four coals carbonised at rather higher temperatures in narrow, vertical, brick retorts. The tars in the first two groups show little difference in their amenability to hydrogenation-cracking, but those of the third were definitely more difficult to treat, although it is realised that this fact may in part result from the adoption of standardised conditions of temperature, pressure, and catalyst, which are not necessarily the best for all types of tar.

In the small discontinuous converters used for these experiments, the pressure, and therefore the hydrogen concentration, varied as the reaction proceeded. The results were therefore not necessarily applicable to a continuous plant such as would normally be used in large-scale operations, and some experiments were at this stage carried out in the Bergius plant at the Fuel Research Station. Having been designed for the hydrogenation of coal this plant was not altogether suitable for the treatment of tar, but the results were nevertheless very satisfactory. With this larger plant there was the further advantage that sufficient spirit could be produced for actual running tests in internal combustion engines. The results of such tests are given in some detail in the report, and show the spirit to be particularly high in anti-knock properties; a slight deficiency in low-boiling fractions caused this particular spirit to be a little inferior to ordinary petrol as regards ease of starting and acceleration, but this feature would easily be overcome by modifying the conditions under which the hydrogenation was carried out. The report also includes the results of some preliminary experiments on the production of lubricating oil from the heavier fractions of the hydrogenation product.

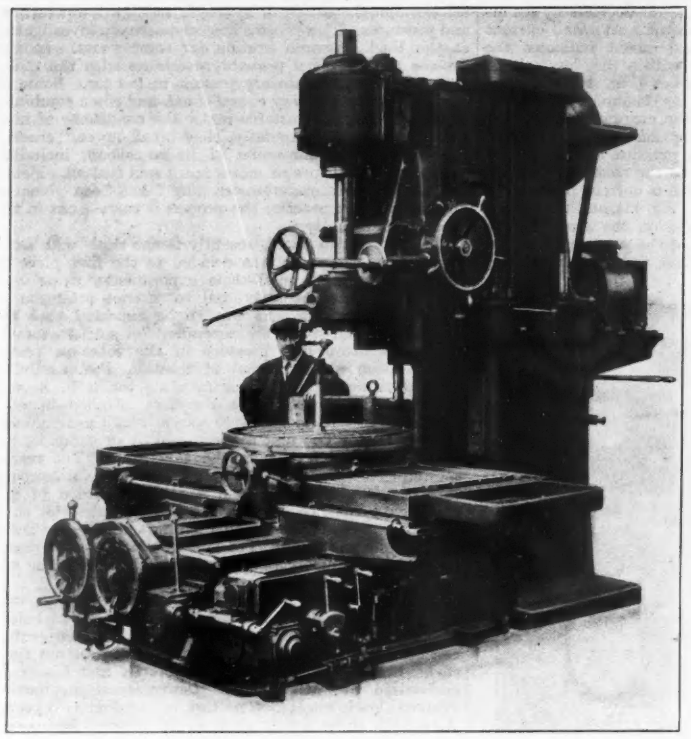
A considerable amount of information bearing on the construction and operation of the experimental plant is to be found in the paper "High-Pressure Plant for Experimental Hydrogenation Processes," read by Messrs. A. T. Barber and A. H. Taylor before the Institution of Mechanical Engineers in November, 1934, and reprinted in our issues of November 23rd and 30th last year.

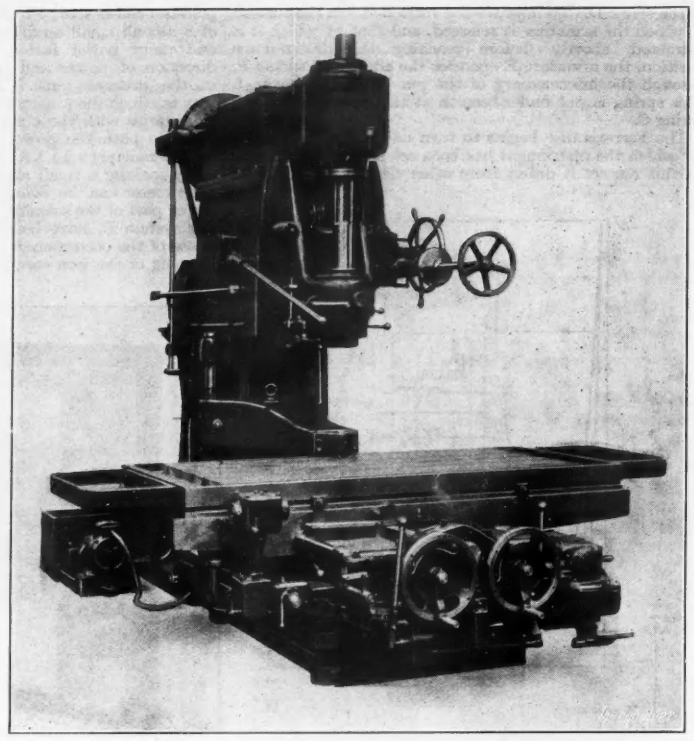
The second paper deals wholly with the important question of the preparation of the catalyst to be used in hydrogenation-cracking. In a continuously operated plant the catalyst may be supplied to the converter as a definite proportion of the material being treated, or it may be held in a static condition while the raw material passes over it. The first of these methods has certain disadvantages, and it was therefore decided to use the second. The requirements of a static catalyst are that it should be granular so as to be easily retained in the system and allow of the free passage of the vapour or liquid, and highly porous so as to present as large a surface as possible to the reacting materials. It should be sufficiently strong to withstand normal handling and mechanical disturbance in the plant without appreciable disintegration, and it should have a high thermal conductivity to ensure the rapid distribution of the heat of reaction. The most promising method of preparing a material satisfying these conditions appeared to be the distribution of the catalyst over a strong and highly porous support. Starting with the assumption that a sulphide of molybdenum is the best catalyst for hydrogenation-cracking, a number of catalyst supports were examined to determine which would give a prepared catalyst satisfying the above requirements. Further experiments were then carried out on enhancing the activity of the catalyst by a preheating treatment and on its reactivation after prolonged use. The results of these experiments indicate that a suitable catalyst for the hydrogenation-cracking of tars or tar oils may be prepared by igniting granular alumina gel to a dull heat and impregnating it with ammonium molybdate in aqueous solution. Certain active carbons gave supported catalysts of higher initial activity, but they suffered from the disability that they could not readily be reactivated. The activity of the alumina-gel-supported catalyst is shown to be increased by preheating in air at 500 deg. Cent. for several hours, and the same treatment restored its original activity after deterioration resulting from continued use.

* Fuel Research Technical Paper No. 40, "Hydrogenation-Cracking of Tar; Part I, Preliminary Experiments" (H.M. Stationery Office, 2s. net). Fuel Research Technical Paper No. 41, "Hydrogenation-Cracking of Tar; Part II, The Preparation of a Catalyst" (H.M. Stationery Office, 6d. net).

MOTOR-DRIVEN HIGH-SPEED MILLING MACHINE

CRAVEN BROTHERS, LTD., REDDISH, ENGINEERS





Motor-Driven High-Speed Milling Machine.

THE accompanying illustrations represent a powerful motor-driven vertical milling machine with and without a circular table, which has recently been built by Craven Brothers, Ltd., Reddish, near Stockport. It is of the all-geared type with the electrical equipment built into the upright column. The bed and the upright column are separate castings tongued and bolted together in a vertical plane, and the slides are of square section for both the spindle slide and table. The gear-box mounted on top of the column gives sixteen changes of speed, through heat-treated steel gears on splined shafts carried on ball and roller bearings. The control for starting and stopping is by means of a friction clutch and brake, and the control levers are within easy reach of the operator. The gear-box extension at the front end forms the housing for the spindle drive gearing. The reduction gear is of the bevel and spur pattern with helical teeth, all shafts being mounted on roller bearings.

The motor gives 20 h.p. at 1200 r.p.m. and drives the clutch on the gear-box shaft by tex-rope. It is bolted direct to the machine and the control mechanism is built into the column. A lever conveniently situated is provided for starting and stopping the machine and the clutch for starting is of the disc type, a brake being used for stopping. Both these operations are performed by the one lever. High-carbon heat-treated steel is used for the spindle, which is splined at the driving end. It has a double ball bearing for location and thrust purposes and is supported at the lower end in a special type of roller bearing. The spindle is mounted in a slide which is balanced and fitted to the square section ways on the column, the slide having both fine and quick adjustment by hand, with quick locking mechanism and vernier for setting the depth of cut.

The cutter mandrel support is provided for use with heavy profile and other slab milling operations and the support is adjustable vertically. When it is not required the support can be swung clear of the tables. The rectangular work table is mounted on long slides and has taper strip adjustment, with machined T slots, and there are swarf collecting troughs at each end. The 30in. circular table, which is detachable, is adjusted by hand for the circular movement and there is a reversible feed through reduction gearing. The latter is left permanently in position on the bottom slide when the table is removed, and when it is in use the main feed control lever also controls the feed for the table, thus giving a quick rotating movement.

The transverse slide has wide square section ways and taper strip adjustment, the slides being covered as far as possible by telescopic guards. Feed and quick traverse in both directions is by screws of large diameter, while the table can be easily adjusted by a hand wheel. One lever of the "joy-stick" type gives easy control of the movement of either slide in both directions. The feed engagement is by a drop worm having trip action which operates in any direction and the quick traverse is driven through friction clutches of the cone type. The feed gear-box provides sixteen changes of feed, 1in. to 24in. per minute, the changes being controlled while the machine is in operation, if desired. The feed gear is of the independent motor-driven type, a friction clutch being arranged in the feed drive, which is released by means of a foot lever when the changes of feed are required. The gears are thus almost idle when changes are made. There is also a safety slipping clutch for the feed drive. A separate electric motor built into the gear-box operates the feed and quick traverse motions, and electrical means are provided to stop the feed motion automatically should the operator stop the spindle with the feed in operation.

A motor-driven gear pump and tank, placed in any convenient position, provides the supply of coolant, which drains back from the channel at the side of the machine to the tank. Lubrication of the moving parts is as far as possible performed by "one-shot" pumps. In other places an oil gun is used. The following are the leading dimensions of the machine :—

Spindle diameter at splined driving end	4in.
Table :	
Working surface	6ft. by 2ft. 7½in.
Longitudinal traverse	5ft.
Transverse traverse	3ft.
Centre of spindle to vertical slide	2ft. 6in.
Table to spindle nose (max.)	3ft.
Table to spindle nose (min.)	7in.
Spindle speeds	16
Spindle speeds range	15–250
Feeds (number)	16
Feeds range	1in. to 24in.
Approximate net weight exclusive of electrical equipment	11¾ tons

A smaller machine of the same pattern with 3½in. spindle is also made.

The Annual Railway Accident Report.

THE annual report on the accidents of 1934, prepared by Colonel Mount, the Chief Inspecting Officer of Railways, has just been issued as Command Paper 4943. As we have on previous occasions maintained, the safety of railway operation must be gauged more by the number of accidents than by the results. There were two fatal accidents last year, both collisions, and they caused the death of seventeen passengers and four servants. But there were in all 256 collisions of all sorts. The latter figure may be compared with 211 in 1933, 180 in 1932, and with an annual average of 269 for the four years 1925–29. That suggests that in times of reduced trade there are fewer mishaps. The better conditions for business here in 1934 are shown in a table given by Colonel Mount in the summary to his report. It is there indicated that in 1934 the net ton-miles, in millions, were 16,219, as compared with 15,026 and 14,942 in 1933 and 1932 respectively, and with an annual average of 17,562 for 1925–29. The increase in business will also explain the increase in the fatalities to railway servants in "movement" accidents, *i.e.*, accidents due to the movements of trains and vehicles other than train accidents. They numbered 204 last year, as compared with 152 and 167 in the two preceding years, and whilst the figure was slightly higher than the annual average—201—for 1925–29, it was lower than the 241 annual average for 1920–24. There were 162 derailments of all kinds reported, and 4958 accidents to, or failures of, rolling stock or permanent way. Both these figures are lower than in any corresponding period mentioned in the report.

Of the 810 train accidents reported last year it was considered advisable to inquire into only sixteen—eleven by formal investigation, with the usual subsequent report, and five, presumably, by correspondence or verbal inquiry. Eight of these related to collisions, six to trains running into obstructions, and two to failures of equipment on locomotives. Of the collisions, the driver was at fault in four cases, the signalman in three, and a ganger, in the use of a motor trolly on a single line, in one. Of the other than the more serious cases, *e.g.*, where there was a loss of life, the inspecting officers held inquiries into only those which suggest irregular working, insufficient supervision, &c., and one of the many testimonies to the high standard of operative and engineering administration is that the number of the accidents which it was considered advisable to inquire into was less than 2 per cent. Recommendations were made in thirteen of the sixteen reports; in five they were adopted, wholly or in part; not adopted in one, and the remaining five of the thirteen are still under consideration. Of those mishaps inquired into, automatic train control would probably have prevented the collision at Doncaster—see page 89 of THE ENGINEER, July 27th, 1934—and track circuit would have avoided the fatal collision of September 28th at Winwick Junction and one other collision. The recommendation in the latter two cases was adopted.

The failures of couplings has fallen, year by year, from an annual average of 8701 for 1925–29 to 4679 in 1934. This satisfactory decrease is considered to indicate that steel of increased strength and of better quality is being used. Of the coupling failures last year, 3804 were on goods trains and 62·07 per cent. of them were due to the pulling-out or breaking of drawbars or hooks; 24·84 per cent. to the breakage of coupling links; and 4·60 per cent. to the breaking of screw shackles. Thus the chief liability to failure lies in the weakness of draw gear.

In view of the prominence given of late to the alleged danger of level crossings, it should be said that there are 4567 public road level crossings, whilst the number of occupation crossings and of footpath crossings must run into tens of thousands. Despite that large number of crossings, only 210 accidents of all sorts were reported. The accidents at public roads numbered 153, in 24 of which there were casualties involving the death of nine persons, two of whom were occupants of road vehicles, two were railway servants—presumably crossing attendants—and five were pedestrians. The two occupants of road vehicles and four of the five pedestrians were considered to have shown a lack of caution.

Of the 204 fatalities to railway servants in "movement" accidents, 64·71 per cent. were considered to have been due to want of caution or misconduct on the part of the person concerned, and 21·08 per cent. were deemed due to misadventure or were accidental. Of these 204 fatalities, 63 were men working on the permanent way and 80 men walking or standing on the line on duty or when proceeding to or from their work. Colonel Mount mentions that of the casualties to men working on the permanent way, 65 per cent. were due to want of care. He therefore observes that the personal attention of gangers and of others on whom rests largely the responsibility for the protection of the men under their control is strongly advocated.

Another class of accident dealt with in the report is the "movement" accidents to passengers. Last year out of 91 passengers killed on the railway and 7101 injured, these "movement" accidents contributed 68 fatal and 4349 non-fatal cases. Under this heading come 21 killed and 1608 injured when attempting to enter or alight from trains and 2012 injured by the opening or closing of carriage doors at stations.

ORDERS in hand at the Swedish shipyards now totals thirty-one vessels of together 180,000 gross tons, an increase of eight vessels of together 60,000 tons since January 1st this year. These orders are reported to exceed the total added orders of the Danish and Norwegian shipyards.

ACCORDING to the 1935 League of Nations Armament Book, issued at Geneva, the air strengths of principal countries are given as follows :—France, 2286; Japan, 1941; Italy, 1861; Britain and British Possessions, other than India, 1434; U.S.A., 1130; Roumania, 799; Poland, 700; Czechoslovakia, 546. It is noted, however, that accurate comparison is impossible, owing to the different definitions supplied of reserve and training machines.

Rail and Road.

AT a recent meeting of the permanent commission of the International Railway Congress Association, it was decided that the next Congress—the thirteenth session—should be held in Paris in 1937.

THE bridge known as Causey Arch, near Stanley, in Co. Durham, has been scheduled as an ancient monument by the Office of Works. It was built in 1727 to carry a wagon-way across Houghwell burn, and has a span of 105ft.

JUDGING from the reply made by the Minister of Transport to a question by Mr. Alan Chorlton, it would appear that the two railway companies interested in the electrification of the railways in South Lancashire are making a joint examination of the possibilities.

THE rebuilding of the Queen's Hotel, Leeds—one of the former Midland Railway hotels—is to be started in the second week in August, and reconstruction will cover a period of two years. The hotel and catering facilities will be maintained throughout the transition period.

WE noted herein on July 12th that at the end of the twenty-sixth week the published traffic receipts of the L.N.E.R. showed a decrease of £26,000 for the half-year. At the end of the twenty-eighth week that decrease was changed into an increase of £22,000; moreover, the increases in traffic for the three other main line companies had risen as follows:—L.M.S., to £371,000; G.W., £109,000; Southern £34,000.

ANSWERING a question on July 18th as to the application of the South Wales Coalowners' and Cokeowners' Association for an inquiry to be set up to investigate dock charges at south Wales ports, it was said the Minister of Transport had required the Great Western Railway Company, as the owner of the docks, to show cause why the charges in question should not be submitted for revision to the Rates Advisory Committee.

IN the death on July 16th in his seventy-sixth year of Mr. Alexander Muirhead, there passed away one of the ablest officers of a generation ago on the Indian railways. Mr. Muirhead was known as a "traffic," *i.e.*, railway commercial, man. He held high positions on the Madras and Southern Mahratta and the Great Indian Peninsula, but ended his railway career in 1919 as agent, *i.e.*, general manager, of the South Indian Railway.

THE collision between a goods train and motor lorry on July 9th, at a level crossing near Lee-on-the-Solent, reminds us that there was—and possibly is still—a level crossing at that place where the gates were opened from across the railway to across the roadway by an approaching train by a fender on the locomotive. A depression bar at the crossing kept the gates closed against the roadway until the train had passed, and a weight, that was raised when the gates were opened, fell and closed them. The railway in question is a light railway.

THE Great Western Railway inaugurated the "Cornish Riviera Limited" train on Monday, July 8th, 1935. One of two specially constructed for the service, the train carries 84 first-class and 364 third-class passengers. Leaving Paddington at 10.30 a.m., the train will run non-stop to Truro (279 miles) on weekdays, except Saturdays, when it will be non-stop Paddington to St. Erth (299½ miles), and the saving in time between London and Penzance will be a quarter of an hour. The rolling stock, running on lines that are an inheritance of the broad guage, is the widest in use in this country. The coaches have steel underframes, fireproof floors, and bodies with steel panelling.

THE Ministry of Transport railway statistics for April have just been issued. As was the case with the March statistics, reviewed herein on July 5th, comparisons with the corresponding period of 1934 are affected by Good Friday being in March last year and in April this year. That incidence is seen in the number of passenger journeys being 7·7 per cent. more in April, 1935, than in April, 1934, and the receipts from passengers having risen by 23·3 per cent. The tonnage of freight rose by 0·8 per cent., and the freight traffic receipts by 2·7 per cent. Freight train mileage was 3·1 per cent. higher, but there was a drop from 127¾ to 125¼ tons in the average train load and the ton-miles per engine hour fell from 469½ to 467¼.

AN American correspondent says that in all the reports of the Welwyn railway accident he has seen in the English technical papers and the daily Press, the car coupler is styled the buckeye, with a small "b," evidently owing to some misunderstanding as to what is a buckeye or the meaning of the term. In point of fact, it is simply a trade name and should be capitalised, the same as a "Thor" pneumatic tool, a "Panther" excavator, or a "Simplex" pump. As to the word itself, a "buckeye" is a species of nut, and as it grows particularly in Ohio, that State is sometimes termed the "Buckeye State." Consequently, many articles manufactured in Ohio get the "Buckeye" as a trade name. Thus the "Buckeye" excavator and "Buckeye" twist drills.

AN otherwise good year, in the matter of railway accidents, was spoilt by the collision of July 17th, 1920—fifteen years ago—at Lostock Junction on the Lancashire and Yorkshire Railway, wherein five passengers lost their lives. The site of the accident is the point at which the line from Wigan joins the Preston and Bolton main line, and thus the up line from Wigan crosses the down line from Bolton to Preston. A local train had stood on the former line and when the station duties were completed the guard gave the "right-away" signal, and the driver started, not noticing that the inner home signal protecting the junction was at "danger" because of a train going to Preston. To give a good running view, the signal was nearly 40ft. above rail level, and Sir John Pringle urged that, as a general rule, it was better practice to place running signal arms and lights at no greater height than was sufficient to ensure a good view by enginemen of from 200 to 400 yards. Where it was necessary to raise arms above 20ft., repeating arms and lights should be provided, not only to meet weather conditions, but to enable enginemen, standing within short range of signal posts, to readily observe the signals.

Miscellanea.

THE Italian Inter-Ministerial Committee has authorised the erection in Italy of a new plant to manufacture rayon staple fibre for a total yearly output of 49,000,000 lb.

THE British Gas Federation has decided that the gas industry shall give active support to the heavy section of the British Industries Fair at Castle Bromwich next year.

BRITISH engineering manufacturers are co-operating with the New Zealand Dairy Board in a joint exhibition at Corporation-street, Birmingham, which was opened on Thursday, July 18th, and will continue until Thursday, August 1st.

THE Board of Education has issued a summary of the conditions for the award in 1936 of Royal Scholarships and Studentships in Science and of Whitworth Scholarships in Mechanical Engineering. The scholarships are open to British subjects and the examination will be held in April. Copies of the pamphlet may be obtained from the Board of Education, Whitehall, London, S.W.1.

THE Garnock Valley drainage scheme was recently inaugurated by Sir Arthur Rose, the Commissioner for Special Areas in Scotland. It will cost £161,500, and when completed will prevent the pollution of the river Garnock, and deal with the sewage of Beith, Glengarnock, Kilbirnie, Dalry, Kilwinning, and Stevenston. The total length of sewers from Beith sewage works to the point of discharge in the Firth of Clyde will be over 12 miles.

THE Board of the Institute of Physics, at the request of a number of corporate members resident in the Midlands, has created a Local Section of the Institute of Physics in the Midland area. The districts represented by the application are Birmingham, Leicester, Nottingham and Rugby. It is intended to hold the inaugural meeting early in October, probably in Birmingham. Further information may be obtained from Dr. J. H. Mitchell, F. Inst. P., the Research Laboratory, the British Thomson-Houston Company, Ltd., Rugby.

THE American Bureau of Mines estimates the output of metallic cadmium in the United States last year as having been 2·78 million pounds, a 22 per cent. increase on 1933. The output of cadmium salts (in terms of cadmium metal content) also improved considerably, namely, from 401,000 lb. in 1933 to 567,000 lb. in 1934. The salts manufactured included the sulphide, oxide, hydroxide, sulphate, carbonate, and selenide, in addition to cadmium lithopone. Imports of metallic cadmium into the U.S.A. last year were 126,000 lb., of which 77,000 lb. came from Norway, 29,000 lb. from Germany, 11,000 lb. from Belgium, and 9000 lb. from Holland.

THE Inventors' and Patentees' Exhibition held in conjunction with the Leipzig Fair is the only Inventors' Exhibition recognised by the German Commercial Propaganda Department. This section was reorganised for the Spring Fair, and, in spite of various difficulties, it showed good results, 7·6 per cent. of the exhibitors having found a market for their inventions at the Fair, whilst over three-quarters of them opened up promising negotiations. The Inventors' and Patentees' Exhibition will again take place in Hall 4 on the Exhibition Grounds during the Leipzig Autumn Fair, August 25th to 29th, and should provide a good display of interesting novelties.

THE Third Conference of Empire Survey Officers was opened in London by the Secretary of State for the Colonies on July 23rd, and will continue until August 2nd. The Conference is not open to the public, but an official report of its proceedings will be published in due course. It is being attended by representatives of Canada, the Commonwealth of Australia, the Union of South Africa, the Irish Free State, India, and Northern Ireland, and of about twenty Colonial Dependencies, as well as by representatives of various interested departments, societies, and institutions in this country. The principal object of these conferences, of which the two earlier ones were held in 1928 and 1931 respectively, is to afford opportunities for surveyors from overseas to obtain and exchange up-to-date information as to the progress made in survey matters and for discussions on questions of general interest to surveyors.

IT is reported by our contemporary journal, *Mining and Metallurgy*, that the Battelle Memorial Institute undertook to determine the properties of copper-alloyed grey and malleable cast iron with the following results:—In grey irons, copper increases the tensile and transverse strengths and the hardness, there being no diminishing in its effect up to at least 4 per cent. Irons alloyed with both copper and nickel were equal in properties to the copper or nickel irons of the same total alloy content. Copper has a mild effect in reducing chill. In malleable iron, copper speeds up the graphitisation, raises the tensile and particularly the yield strength, increases the hardness, modifies the galvanising embrittlement effect, promotes corrosion resistance, and makes the iron amenable to precipitation hardening. Since it retards the rate of transformation, copper assists in the heat treatment of grey or malleable iron by retaining certain structural features, obtained in unalloyed irons only on rapid quenching, at much reduced rates of quenching.

THE centenary of Southend Pier was celebrated on Tuesday, July 23rd, when Lord Ritchie, the Chairman of the Port of London Authority, unveiled a plaque at the pierhead to commemorate "a century of progress." Probably the best-known feature of the pier is its electric railway, which carries about two million passengers each year. It runs the full length of the pier, 1¼ miles, covering the distance in about 3½ minutes. Electric railways were not, of course, in existence in 1835 when the pier was built, and the first cars to travel on the pier were horse-drawn. Electrification, however, came in August, 1890, when "Crompton's Electric Railway" was successfully put into operation. It was one of the earliest examples of electric traction in this country. Open-sided cars, picking up current from a third rail, were employed. The car motor was of 13½ b.h.p., supply volts being 200. The efficiency of the motor was approximately 85 per cent. without gears; the weight was 89 lb. per b.h.p., and the motor speed was 500–600 r.p.m., giving a speed for the car of 20 m.p.h.

Air and Water.

LAID-UP tonnage in Sweden has decreased during June by 24,000 tons d.w. to 161,000 tons. This figure compares with 191,000 tons a year ago.

THE one hundredth Atlantic crossing of the German liner "Europa" began on Friday, July 26th, when she sailed from Bremerhaven for New York.

THE new Leicester municipal airport at Braunstone was officially opened on Saturday, July 13th, by Sir Philip Cunliffe-Lister, Secretary of State for Air.

THE Russian Government has decided to construct sixteen aeroplanes of the same size as the "Maxim Gorky," which crashed with the loss of over fifty lives in May.

A NEW R.A.F. base on Thorney Island, Emsworth, Hants, is to be constructed at an estimated cost of £500,000. The base will provide accommodation for five squadrons and a training flight.

ADMIRAL ALFREDO BAISTROCCHI, a member of the Italian State Council, has been appointed the President of the Registro Italiano Navale ed Aeronautico, in succession to Admiral G. Sechi.

THE Board of Trade announces that the International Convention for the Safety of Life at Sea, 1929, has been ratified by the Soviet Government, and will become operative in the U.S.S.R. on October 2nd.

THE United States Lines liner "Leviathan," which is now laid up in New York, is, according to a recent proposal, to be used as a school ship, particularly for the training of Americans as ships' stewards.

THE American stratosphere balloon "Explorer II," collapsed on Friday, July 12th, at Rapid City, South Dakota, soon after it had been inflated for a scientific flight. The cause has not yet been stated.

A NEW de Havilland "Hornet Moth" two-seater cabin aeroplane has been designed, which is intended to take the place of the ordinary "Moth" machine for training and touring. It has a top speed of over 130 m.p.h.

A NEW shipping line, the German Levant Line Hamburg, Ltd., has been formed to take over the ships hitherto employed by the Hamburg-Amerika Line on the Levant service, as well as three liners of the Norddeutscher Lloyd Line.

THE President of the Board of Trade, Mr. Walter Runciman, has announced his intention of making a considered statement at an early date on the various matters arising out of the findings of the court in the recent wreck inquiries.

ONE of the two destroyers under construction at John I. Thornycroft's Woolston Yard, Southampton, was launched on Monday afternoon, July 22nd, and was named H.M.S. "Glowworm." Her sister ship, the "Grafton," will be launched in September.

ARRANGEMENTS are being made for an early air service between Stornoway and the mainland. The new service will be operated by the seaplane "Cloud of Iona" from Stornoway to Portree, Kyle, and Mallaig. Next spring it is hoped to bring into operation a service by aeroplane from Stornoway to Inverness.

ON Thursday, July 19th, the first keel plate was laid at Devonport of the new 9000-tons cruiser "Birmingham." The ceremony was performed by Lady Plunkett-Ernle-Erle-Drax, wife of Vice-Admiral Sir Reginald Plunkett-Ernle-Erle-Drax, who turned a switch which placed in position a plate weighing 9½ tons.

IT is proposed that the conference between representatives of the Shipbuilding Employers' Federation and the shipyard trade unions, to consider the unions' application for an increase of wages of 2d. per hour for time workers, with an equivalent advance to pieceworkers, shall be resumed at Edinburgh on Friday, July 26th.

A REPORT from Cape Town states that the Holland-Africa Line's motorship "Jagersfontein" has completed the voyage from England in 15 days, 15 h. 40 min., which is claimed to be the fastest passage in this century. The "Jagersfontein" failed, however, by 20 h. 44 min. to beat the record established in 1893 by the Union Steamship Company's ship "Scot."

A 15FT. model of the "Mauretania," weighing nearly two tons, has been placed in the Mariners' Chapel in Winchester Cathedral, and was dedicated on Tuesday at the Annual Shipping Festival. President Roosevelt has directed that an 18ft. model of the "Mauretania" be placed in the Smithsonian Institution at Washington and remain permanently among the models of other famous ships.

AT a recent meeting of the Edinburgh Chamber of Commerce, Mr. A. Wallace Cowen, the President, stated that in Scotland there were many suitable sites for aircraft factories, where there could be put down not only the factories but the dwellings for the employees, along with testing and landing grounds adjacent to or near to water, which would be much more remote from the possibility of attack than similar sites in the south.

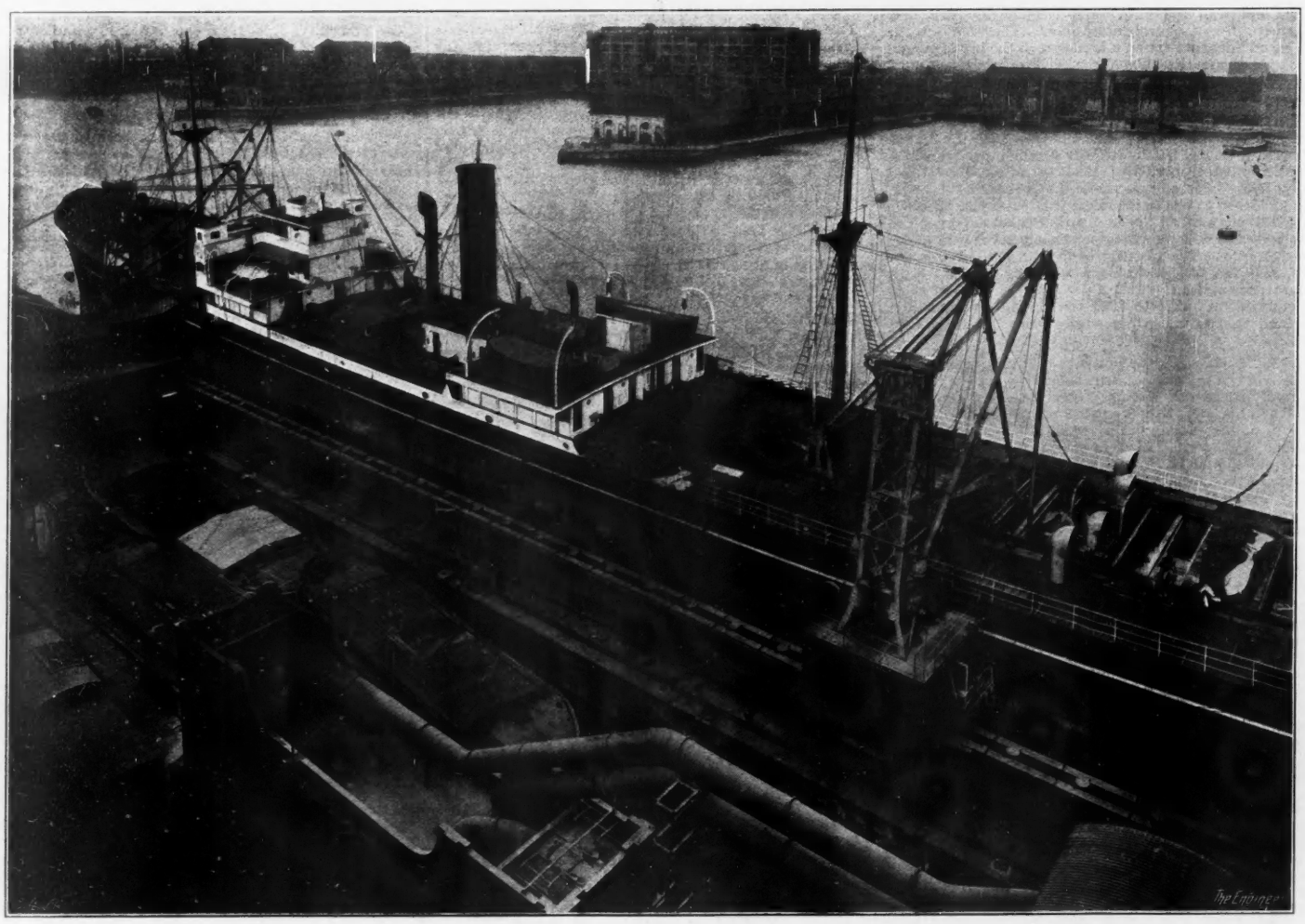
THE Italian salvage steamer "Artiglio" reached Plymouth on Friday, July 12th, and landed gold bars and sovereigns valued at £45,000, which had been recovered from the lost Indian mail steamer "Egypt" off Ushant. The treasure comprised ten gold bars of 400 oz., eight bars of 100 oz., and about 7000 sovereigns, and was sent to London. Since the wreck was located seven years ago, approximately 98 per cent. of the bullion has been recovered representing a value of over £1,000,000.

IN a note on July 12th, we referred to Lord Strickland's proposal to make Malta a central seaplane base. In the House of Lords on Monday, July 15th, Lord Plymouth said that while the Government recognised Malta as a link in the chain of Imperial defence, it was quite clear that Malta would be unable to finance the scheme from her own resources, and the Government at home could not at the moment make any contribution towards it. No profitable purpose therefore would be served by the preparation of plans.

PNEUMATIC GRAIN DISCHARGING PLANT AT THE VICTORIA DOCKS, LONDON

HENRY SIMON, LTD., STOCKPORT, ENGINEERS

(For description see page 97.)



The Engineer

JULY 26, 1935.

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NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

*** *Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

UNEMPLOYMENT IN "SPECIAL" AREAS.

WE wish that there was any probability, even the slightest, of Mr. Malcolm Stewart's report on the Special Areas of England and Wales becoming "a best seller." Living, as the world has done for some years, in an atmosphere of academic and theoretical cures for unemployment, it is refreshing indeed to meet with an essentially practical investigation of the problem in those areas where the ill is most pronounced. General unemployment of labour is decreasing and will continue to decrease; local unemployment is as high as ever, and the practicability of removing it under sound economic conditions is very small. Mr. Stewart admits as much, whilst submitting a scheme which he thinks might be useful, but of which he sees the difficulties. The honest fact is that if all humane feelings and sympathy with the families which have been established in the affected areas for generations, and which are bound to it by local ties, could be put ruthlessly to one side, the right, the logical, and the best course for national economics would be to allow those areas to slip slowly back into the simple conditions which prevailed in them before they were industrialised. In the end that must happen, unless new industries for which they are topographically fitted arise, and the real question is how long, and to what extent, the progress of retraction should be purposely delayed? Manifestly, it is economically absurd to maintain a mining village when the mine has ceased to work; but humanely it may be the duty of the country to make the passing so slow that the older villagers may die in peace, whilst the younger are seeking other areas for the profitable use of their labour.

To give an adequate idea of Mr. Stewart's report in the small space which we can devote to it is impossible. Happily, the few years of hardship have bred amongst engineers, particularly of the younger generations, an interest in economics which barely existed when prosperity ruled. It is the sick man who turns to "Quain"; the well man leaves such works to the professors of medicine. Hence we may expect that amongst our readers there are many more than a few years ago who will study the Report with the care that it merits. Mr. Stewart is one of two Commissioners appointed under an Act barely six months old, to investigate the conditions in the depressed areas of the kingdom and to promote schemes for helping those areas out of or through their troubles. During the passage of the Bill "depressed" was changed by the House of Lords to "special," and we use the former word momentarily because it is explanatory, which the latter is not. The areas which have fallen under Mr. Stewart's examination lie in Durham, West Cumberland, and South Wales. They are mining districts. The percentage of unemployment in them in May last was 34·5. The average, all industries, for England and Wales, was 15½ per cent. "Frankly," says the Commissioner, "I see no prospect of any effective reduction under existing conditions. The economic reopening of many of the closed mines and works and the finding of adequate markets to absorb their products could not be procured by a dictator with unlimited powers of expenditure. He could apply palliatives on a lavish scale, but no permanent relief would be afforded." Later, when reporting conversations with miners, he says, "I told them frankly the first thing to be determined was whether their district was on or off the industrial map, and, if they were off, there was probably no power that could in their lifetime restore its industrial activities." No doubt such statements as those we have quoted will cause Mr. Stewart to be labelled a "defeatist." But when so many people are wilfully blind to economic truths, all those who believe that no good can be done save by looking upon facts as they would upon scientific observations, will welcome Mr. Stewart's candour. Having established the facts we should act on them. The brave action of National Shipbuilders Security, Ltd., in dismantling unwanted shipyards is certainly far better than bolstering them up and encouraging the vain hope that someday they may be needed again; the removal of tin-plate works from Swansea to Lincolnshire is in harmony with economic progress. Mr. Stewart presses his point home. "If we are to survive as an industrial nation," he writes, "we must increase production efficiency; if our workers hereafter are to enjoy the maximum of continuity of employment with improving prospects, economic considerations must in the main determine the location of industry. . . . It is futile to attempt to establish industries in the Special Areas when the economic facts do not warrant so doing. It would only afford temporary relief, bearing the seeds of further future distress, which is avoidable." But even whilst Mr. Stewart is recognising that palliatives are fruitless, he recommends their adoption. In that he is, no doubt, acting according to instructions. The doctor who is unable to cure a malady does his best to relieve the patient from distress. In the case of those areas for which there is little or no present hope, it is the duty of the nation to ease the lot of the sufferers. The Government gave Mr. Stewart something like a million pounds to expend upon his "special" areas, and he has therefore put before the Minister of Labour proposals for the spending of that amount. No one will blame him, and most will commend him and the Government for their action. But at the same time, nothing should be done that would encourage the youth of the country to remain in districts which have become industrially useless to the country. Our only criticism of Mr. Stewart's Report is that in it he does seem to advance schemes and suggestions which may encourage hopes that are not likely to be fulfilled. Fictitious prosperity, as he himself sees, must in the end do more harm than good.

The problem before Mr. Stewart was to find out if there were any means of providing profitable work for the three or four hundred thousand persons in the special areas under his supervision. He has, we think, seen more clearly than many others that unemployment is a symptom and not a disease. The disease is the diminution of industries, and unless it can be cured we may go on treating unemployment for ever at much cost and with no benefit. That obvious fact ought to be constantly insisted upon, for it is only by encouraging industries by every means in the nation's power that the symptom itself can be permanently removed. It is gladly admitted that the Government has done a great deal to ease the path of industry and to help it forward to greater health. The decrease of unemployment in all save the Special Areas is certainly in part due to the efforts of the Government to encourage manufacturers. But more must be done, and more could be done by a Government which would reject completely the socialistic theory that the State can replace the capitalist. Profitable capitalism is the key to the extension of industries, and, what is of even greater consequence, to the discovery and development of new industries. We have no desire to see the Government advancing money for new industries, or supporting those that are languishing by subsidies. We would prefer to see the industries stand upon their own feet. That, we believe, can best be brought about by encouraging the flow of money through the industries of the country rather than by heavy taxation and colossal expenditure by the State. What the State gets the investor loses, and he is therefore not in the position to support the means by which unemployment is best reduced. "What does the past reveal?" asks Mr. Stewart. "Districts usually favoured with the endowment by Nature of much latent wealth; undeveloped it was worthless. It was not the Government or the big London banks that procured its development and brought about prosperity. This was achieved by the enterprise, the foresight and courage of individuals. It was the result of their effort and of their work that South Wales and Tyneside became districts of outstanding industrial activity, and of great commercial influence, much of which remains to this day. It was men with these qualities and characteristics who turned the latent wealth into realised wealth"; and he concludes, after referring to State activities, "the Government has given the lead; gradual revival can come, but the primary effort must be made from within."

Steel Trade Reorganisation.

THE reorganisation of the steel industry and its markets is proceeding very much according to the plans of the steel makers, but apparently to the disappointment of other sections of the community. The Government declared that it granted the industry protection on condition that it reorganised itself, and although since then it has allowed the industry to juggle with tariffs in order to bargain with the foreign steel makers, it may be assumed that it is still alive to its main purpose of promoting an efficient industry able to compete at home and abroad with its rivals. The process of reorganisation may be divided into three departments. The protection of the home market from imports of Continental steel; the control of the market and the forcible regulation of allied industries by bringing them into association with the British Iron and Steel Federation; and, perhaps the most important of all, the modernisation of plant and its concentration at points most suitable for economic production and distribution. Strangely enough, the latter proposals appear to have provoked the most bitter opposition from classes outside the industry. The limitation of Continental imports to figures which suited the British steel makers; the control of supplies of raw materials to competing firms, and their penalisation by excessive charges unless they became part of the steel makers' organisation; the development of movements which threatened to put old-established firms of distributors out of business, all passed without protest, although they were directly opposed to traditional British business methods. Immediately plans were declared for the real work of reorganisation—that is, for the cheapening of production to enable the British steel industry to meet its foreign competitors in any market—opposition developed on so-called humanitarian grounds. The transference of plant from Scotland to the Midlands, although it was obviously in the best interests of the industry and the nation, was strongly objected to; and the proposal to set up a tin-plate-making plant in Lincolnshire has led to something in the nature of a crusade against the plan in South Wales.

Although less publicity has been given to their complaints, many branches of the consuming trades are uneasy at the conditions under which they will have to work in the future. The negotiations with the Continental steel makers have been concentrated principally upon the quantities of the various descriptions of steel which will make up the import quota. It is no secret that the Continental steel makers resent the manner in which their imports have been cut down, and it seems possible that further difficulties will arise in the near future with some home consumers. Progress has certainly been made in the negotiations, and it is generally understood that the quota for strip, which was the most troublesome to settle, has been fixed at 47,000 tons per annum.

Imports of bars, it is reported, will be limited to 160,000 tons, whilst 34,000 tons of plates are to be allowed into the country. Joists to a total of about 98,000 tons may be imported, and wire rods up to 30,000 tons, whilst a quota of 250,000 tons of semis will probably be given to the Continent. Whether these quantities will be sufficient to satisfy consumers remains to be seen. It must not be forgotten that in the past the British steel makers were amongst the largest buyers of Continental material, and at the moment one important firm is seeking to purchase a quantity of steel for working up, since its own production is not sufficient for its needs. As the tonnage this firm requires, if it were deducted from the quota, would leave little for other users in this country, some difficulty has been experienced in obtaining the material, and this illustrates the kind of trouble which may develop in the future. The discussions, however, are by no means completed, and questions regarding uniformity of quoting, prices and extras, present some thorny problems, particularly as there are still works outside the Association movement which have not advanced their prices to the same extent as those which are affiliated to the Federation. The quotations of the former, therefore, act as a brake upon Continental prices. At the same time, the Continental makers are pressing the British to obtain from the Government a reduction in the duties from the prevailing 33⅓ per cent. level to 10 per cent. It is generally known that the home steel makers do not regard with favour a reduction to such a low rate, but would be prepared to acquiesce in the duties being fixed at about 20 per cent. in the case of most descriptions of steel. It will be seen, therefore, that much ground remains to be covered by August 7th, when the present agreement between the Cartel and the Federation expires, and opinions differ as to the possibility of a satisfactory agreement being reached by that date.

The whole trade is undoubtedly heartily tired of the present position, and would welcome a settlement with the Continent. There is no doubt that eventually the British steel makers will get their own way in the home market, whatever may be the outcome of the discussions regarding export business. A notable advance has been made only recently in bringing into alignment those constructional engineering firms which for months have been struggling to maintain their independence. The majority of constructional engineers joined trade associations and became affiliated to the British Iron and Steel Federation. Next came an announcement that at the end of July the prices of structural steel to firms which were not in associations affiliated to the Federation would be increased to a figure 30s. per ton higher than that quoted to affiliated firms. It is understood that this has forced practically all the independent firms to join the Association movement. At the same time, there are proposals under consideration which, if agreed to, will make it difficult for constructional engineering firms, which do not carry out actual fabricating and erection work, to continue in business. On the other hand, little has been done to meet the complaints of constructional engineers that the steel works are unfairly competing with them in their own particular line of business. Recruits obtained in this way can scarcely be a source of strength to an organisation, especially as one of the most efficiently conducted works remains outside the Federation and has pursued an uninterruptedly prosperous career. This is a factor which makes agreement with the Continent on prices difficult with regard to some materials, since the foreign steel makers can with truth point out that the Federation is not in a position to control the whole industry. Now, as we have already indicated, troubles of another character seem to be in store for those steel makers who seek to increase the efficiency of their plant by modernisation and by migrating to more satisfactory sites, and these may prove a greater obstacle to the building up of an efficient steel industry than any of the difficulties to which we have referred.

More Grid Trouble.

ALTHOUGH the Central Electricity Board's annual reports rarely refer to trouble, it is common knowledge that the grid has not escaped the mishaps that are liable to be associated with overhead lines and outdoor electrical equipment, such as transformers. Experience has shown, for instance, that more adequate lightning protection than that provided is essential, and extensive investigations are being carried out with a view to finding the best ways and means of grappling with lightning discharges. Most of the troubles, we believe, have been met with on the secondary lines, which for the sake of convenience are generally neglected when referring to the grid's satisfactory performance. Lightning troubles are frequently reported in the daily Press, but rarely in the Board's reports. The prolonged failure of the supply at Canterbury and Herne Bay on August 31st of last year served, among other misfortunes, to indicate that despite the interconnection of power stations, continuity of supply is not necessarily ensured by the establishment of a grid system. A record of all the failures that have occurred on the primary and secondary lines would be both interesting and instructive, but the Board's policy is to conceal, rather than reveal, its troubles. The latest mishap reported by the newspapers is the outbreak of a fire at the Ferrybridge grid sub-station near Pontefract, on July 15th. As usual, no official explanation of the cause appears to have been issued. All that is known is that a transformer containing about 10,000 gallons of oil caught fire and the damage is estimated at about £15,000. Such typically useless items of news, as that the flames leaped to a height of 50ft. and that dense columns of smoke hung like a heavy cloud for miles round are circulated, but the cause of the fire is unexplained. As is generally the case on these occasions, we shall probably hear in due course that the cause has been undiscovered, or that no definite conclusions can be drawn. While it is obviously undesirable that the public should gain the impression that the grid will always be liable to ailments, a little more plain speaking on the part of the Board's engineers would be appreciated by supply engineers and electrical designers alike.

The North-East Coast Institution of Engineers and Shipbuilders.

No. 1.

IN our issue of July 12th we published an appreciation of the work of the North-East Coast Institution of Engineers and Shipbuilders, and referred to the Jubilee Meeting which took place in Newcastle-upon-Tyne from Tuesday, July 16th, until Friday, July 19th, at which the first half-century of the Institution's existence was appropriately celebrated. The weather was excellent, and in spite of the rival attraction of the Royal Naval Review, a large gathering of members and of delegates from all parts of the world attended the meetings.

The official reception took place in the King's Hall of Armstrong College by Principal and Lady Marris on behalf of the Council of Armstrong College, and by the President, Dr. John T. Batey, and Mrs. Batey, on behalf of the Council of the Institution. During the evening a number of the laboratories were open for inspection, and Professor W. E. Curtis gave a short demonstration of the properties of waves by means of a ripple tank and other apparatus installed in the Physics Laboratory. On the morning of Wednesday, July 17th, a short Thanksgiving Service was held at St. Thomas's Church, Barras Bridge, near to Armstrong College, which was conducted by the Rt. Rev. the Lord Bishop of Newcastle, Dr. H. E. Bilborough, and the Vicar of St. Thomas's. After service the members went to the King's Hall of Armstrong College, where the first meeting for the reading of papers took place. Before proceeding to business, the meeting instructed Mr. E. W. Fraser-Smith, the Secretary of the Institution, to send a telegram to His Majesty the King, the Patron of the Institution, assuring him of its loyalty, and expressing gratification that he was again the Patron of the Institution in its Jubilee Year. Dr. John T. Batey, the President, welcomed the members and visitors, especially the overseas delegates from France, Germany, Italy, America, Japan, and Holland. A welcome was also extended by the Lord Mayor of Newcastle-upon-Tyne, Councillor R. S. Dalgliesh, and the Sheriff, Alderman Oliver. After the visiting guests had presented official greetings from kindred societies, there followed the ceremony of conferring Honorary Fellowships on Mr. G. S. Baker, Superintendent of the William Froude Laboratory; Engineer Vice-Admiral Sir Harold A. Brown, Engineer-in-Chief of the Fleet; Sir Cecil A. Cochrane, Chairman of Armstrong College, 1923 to 1935, and Sir Arthur W. Johns, Director of Naval Construction.

Then came the presentation of illuminated mementoes to the twelve surviving Founder Members of the Institution: Mr. R. B. Charlton, Senr., Mr. J. Denham Christie, Mr. W. G. Green, Mr. A. H. Haver, Sir George B. Hunter, Mr. G. F. Mulherion, Mr. F. R. Noton, Mr. Ernest Scott, Mr. William Scott, Mr. W. G. Spence, Professor R. L. Weighton, and Mr. P. D. Winstanley. Sir George Hunter received a remarkable ovation from the delegates, and he and Mr. Spence briefly replied. Mr. Spence referred in his speech to the early days of the Institution, and said that when they founded it they had builded better than they knew. Sir George Hunter, on behalf of the Founder Members, said that they felt justly proud of the Institution and its work, not alone for what it had done for the North-East Coast, but for what it had accomplished for science and industry at home and abroad. It was, indeed, a pleasure to them to know in what high esteem the Institution was held throughout the world. On behalf of the Founder Members Sir George presented to Dr. Batey a bound volume of the first year's "Transactions."

The M. C. James Memorial Medal was then handed to the Institution by Mr. M. I. James, one of the sons of the late Mr. M. C. James, a Founder Member, to be awarded annually as the Council thought fit. It was presented for the first time to Mr. R. A. MacGregor, Mr. W. S. Burn, and Professor F. Bacon for their joint paper on "The Relation of Fatigue to Modern Engine Design." Three papers, prepared in the nature of reports, were then read but no discussion followed. These papers dealt with "Developments in the Construction of Ships during the Past Fifty Years." They were prepared by Mr. J. Denham Christie, Mr. John McGovern, and Mr. F. W. Dugdale, and dealt with liners, cargo ships, and tankers, and coasters respectively. These papers are excellent summaries of the advances made in the period under review, and there is no doubt that they will come to be looked upon as valuable reviews of shipbuilding progress.

The paper given by Mr. J. Denham Christie on "Liner Development during the Past Fifty Years" is noteworthy for its inclusion of a complete range of 'midship sections, engravings of ships, and tabulated particulars of hull, propelling machinery, and performances for express and intermediate passenger liners built during the period under review for North Atlantic, South American, Far East and Australia, South African, Transpacific, and other services. Not only are British-built liners included, but also the principal liners built abroad, It is recalled that in 1888 the Cunard liner "Etruria," a single-screw ship with compound reciprocating engines of 14,500 i.h.p., made the crossing from Liverpool to New York, a distance of 2855 nautical miles, at an average speed of 19½ knots in 6 days 1 hour and 55 minutes. Compared with this performance the present-day quadruple-screw liner "Normandie," now in commission, and the "Queen Mary," under completion, will make the 3200-mile crossing from the English Channel to New York in 4½ days at speeds over 30 knots. Further increase in size for Transatlantic liners seems, Mr. Christie says, unlikely. Instead, probably future efforts will be made in the direction of attaining high speed and other required conditions with smaller dimensions. But on routes other than the Atlantic increase in size may still be found advantageous. Improvements will doubtless continue to be made in propelling and auxiliary machinery to enable power to be obtained with less and less weight, cost, and fuel consumption.

In his paper on "Cargo Ship and Tanker Development during the Past Fifty Years," Mr. John McGovern deals with the outstanding achievements in the design and construction of cargo-carrying vessels, and says that the record was one of steady progress, clearly indicating the ability of the shipbuilding and marine engineering industry to anticipate the ever-changing and expanding transport demands involved in handling the multifarious commodities of seaborne trade. The industry, he finds, has consistently provided suitable craft to cope with improvements in terminal facilities, whether these were in the nature of increased quantities of cargo or longer and deeper harbours. Successful progress has been made, too, in the handling of special bulk cargoes, such as coal, grain, ore, timber, and particularly with the transportation of petroleum in bulk. Reference to the progress made in tanker design and construction was particularly made in Mr. John McGovern's paper read before the Institution in June, 1930. The average cargo vessel in 1885 was, Mr. McGovern says, about 1400 gross tons, with 17ft. draught and about 2300 tons deadweight carrying capacity. The latest statistics indicate a pronounced preference for vessels varying from 7000 to 10,000 tons deadweight, and for general trading about 8500 tons deadweight, 24ft. 6in. draught, with speeds over 10 knots and

lengths from 390ft. to 415ft. In the search for maximum economy an increasing number of tank experiments has been carried out on models of the ordinary cargo carrier, and indicate that improved performance can be secured without going to the extreme limit of firing at present considered necessary to ensure good service results. The various types of cargo ships are dealt with, and the development of the hull traced in turret, self-trimming, and discharging vessels, and the Isherwood "Arcform" ship. Tanker construction is reviewed and its application for oil carrying ships, molasses tankers, and whale factories is reviewed. Dealing with construction, Mr. McGovern finds that we are only at present on the fringe of the possibilities opened up by the introduction of electric arc welding. Owing to the elimination of overlaps and angle flange connections, &c., the saving in weight is a matter of first importance to the shipbuilding industry. Discussing steering gear, Mr. McGovern says that in a large number of cargo vessels the steam steering gear with the somewhat primitive rods and chains leading to the quadrant had strangely persisted with very little change, but signs are not wanting that the much superior steering gear situated under cover and acting direct on to the quadrant through the tiller on the rudder head, with telemotor or other control, while more expensive, would become more or less standard, greatly enhancing the safety of that vitally important equipment. Many very effective electrical steering gears were being adopted, the usual steam gear being admittedly one of the most wasteful auxiliaries on board ship.

The paper presented by Mr. F. W. Dugdale on "Coaster Development during the Past Fifty Years" is a general *résumé* of the progress which has been made in the design of coastal vessels during the period under review, with a short reference to one or two special types of ship which are interesting in view of the recent revived interest in our coastal trade. This paper will be dealt with in a later issue of THE ENGINEER.

After the morning meeting the members met for luncheon at the University Union, and during the afternoon there was a garden party at Blagdon Hall, where the guests were received by Viscount and Viscountess Ridley, and a very enjoyable afternoon was spent.

The jubilee banquet was held on Wednesday evening in the Grand Assembly Rooms at Barras Bridge and was attended by close upon three hundred members, guests, and ladies. It was followed by a dance. During the dinner Dr. John Batey, the President, announced the reply to the telegram sent to the King, which read as follows:—"The King sends thanks for the kind and loyal terms of the message. His Majesty congratulates the Institution on this great occasion in the life of the Institution, and as Patron sends his best wishes for its future welfare." In proposing the toast of "The Guests," the Lord Mayor of Newcastle referred to the capacity of the Tyne for building and equipping naval vessels, and expressed the hope that the river would soon be entrusted with more Admiralty work. In his reply, Sir Cecil A. Cochrane said that in some accounts which had been given of the Institution's jubilee and the Tyne shipbuilding and marine engineering industry cargo and tanker tonnage had been mentioned, but the passenger steamer construction had been overlooked. He recalled that it was a Tyne firm which had built and engined the "Mauretania," the best known, the most successful, and probably the best loved of any ship which ever took the water. Two delegates from abroad, Monsieur A. Berle de Berle, Vice-President of L'Association Technique Maritime et Aeronautique, and Dr.-Ing. E. Foerster, Vice-President of the Gesellschaft der Freunde und Förderer der Hamburgischen Schiffbau-Versuchsanstalt, paid a warm tribute to the pioneer and research work which had been done by the Institution in the fifty years of its existence, which was, they said, keenly appreciated on the Continent. The concluding speaker was Sir Cyril R. Kirkpatrick, Past-President of the Institution of Civil Engineers, who proposed the toast of "The Institution," to which Dr. Batey replied.

(To be continued.)

Literature.

Standard Gear Book. By R. TRAUTSCHOLD. London: McGraw Hill Publishing Company, Ltd. Price 18s. net. 1935.

WHEN it is considered what an important part toothed gears play in mechanical design, it is somet what surprising that the literature relating to them should be so scanty and so poor in quality. There are several possible causes for this state of affairs. The individual problems which arise in gear design are mainly of two kinds—either they do not permit a rigid solution and call for empirical treatment based on practical experience, or they require only moderate skill in algebraic and geometrical juggling. These problems, therefore, have not attracted any considerable attention from independent students, research workers, or those whose training and circumstances best equip them for writing scientifically planned text-books. On the other hand, the problems of gear design, however simple individually, cover a vast range, and the type of mind which, to judge by results, is attracted to these "finnicky" problems is not best adapted to undertake the co-ordination and systematising of the whole subject. Finally, when the gears represent only a minor portion of a design, their calculation is often left to a junior draughtsman, for the benefit of whom most gear handbooks and text-books have been written; the more difficult design problems are usually handled by gear-cutting specialists, who evolve, but rarely publish, their own methods.

Serious attempts to unify gear design practice have, however, been made in recent years, in the United States of America by the American Gear Manufacturers' Association, and in this country by the British Standards Institution. American activity in this direction anticipated the publication of the two British specifications (Spur and Helical Gears, No. 436 of 1932, and Bevel Gears, No. 532 of 1934) by several years, and the results have revealed the difficulty of reconciling either theoretical considerations or originality of treatment with the inertia resulting from diversity of practice and the existence of costly tools and equipment. Clearly, however, the greater this diversity of practice, the lower its average quality and the more important it is that the work already done on the standardisation of method should be circulated as widely as possible.

On this ground, the "Standard Gear Book," by R. Trautschold (McGraw Hill Publishing Company), is of interest. It is the successor of Logue's "American Machinist Gear Book," revised in a later edition by Logue and Trautschold, but the present volume has been almost entirely rewritten, historical and descriptive work in the earlier work giving place to more up-to-date material. The notation throughout is that adopted by the A.G.M.A. and many of the A.G.M.A. standards for design and material specifications are included. The fact that the book provides a convenient source of reference to this work of the A.G.M.A. is its principal recommendation, even although, in this country, there is little incentive or necessity to make use of American standards in actual practice.

American notation is reasonably consistent, convenient for type setting, and capable of wide expansion. It is largely mnemonic; thus, the symbol for base circle diameter is B C D for the wheel, and *b c d* for the pinion. Similarly, V N P represents normal pressure angle, the prefix V denoting an angular dimension. There are, however, exceptions, such as V P G for planet gear velocity. Such a system is convenient enough for most gearing formulæ, which are usually simple, but it may also be regarded as somewhat cumbersome when more complicated work is being done and indicates some mistrust of the ability of those who are to use it to follow any system which looks formidably "scientific." (American handbooks initiated the practice of writing long formulæ in words and calling them "rules" in order to avoid this difficulty.)

An encouraging feature of the book is that more reference than usual is made to the module as a method of expressing pitch. Ultimately this method, so simple and convenient, will become as generally used in English-speaking countries as it now is on the Continent, but the way is long and there are in existence too many cutters made in circular and diametral pitches to permit any rapid change.

Considering practice as such, rather than its presentation by Trautschold, it is interesting to compare American with British design methods as indicated in the B.S.I. specifications to which reference has already been made. The A.G.M.A. formulæ for load-carrying capacity are direct descendants of the original Lewis formula, modified by Barth—a "strength" formula in which the working stress is based on a factor depending upon the pitch line velocity.

The strength factors in these formulæ assume that the load is concentrated along the tips of the teeth (a rare condition which would produce intolerable results); ignore the effect of the number of teeth in the mating gear, and take no account of the rate of repetition of load. British practice in estimating gear tooth strength takes more detailed account of contact conditions and bases nominal working stresses on the rate of repetition rather than on the pitch line velocity. In addition to its other recommendations, which include that of working well in practice, the determination of gear sizes to meet specified conditions is somewhat simpler.

The principal difference between American and British practice, however, revolves round the treatment of the problem of the resistance of gear teeth to abrasion and other forms of surface failure, usually collected under the heading of "wear." Trautschold gives three formulæ, one of which is rather misleadingly described as "favoured by English producers of high-quality, heat-treated steel gears." It does not appear, however, that any of these formulæ represent A.G.M.A. recommended practice, and the material factors, which, in some unspecified way, represent working stresses, are vague and incomplete. In the British specifications, resistance to wear is regarded as the principal factor in load-carrying capacity, and strength as a secondary consideration which can be suitably adjusted by a proper selection of pitch after the principal dimensions, such as pitch diameters and face width, have been determined on a wear basis. Since the material (stress) constants and other factors have been determined and presented in a comprehensive way not attempted in any other publication, some reference to the B.S.I. specification might well have taken the place of such statements as "the hardness of the gear and pinion should be proportioned to their respective speeds of rotation." (?)

One has come to expect that in publications of the "handbook" type (which often attribute a quite unjustifiably low level of intelligence to the draughtsmen and shop men for whom they are intended) attention will be directed to rules, formulæ, and bald statements to the exclusion of any explanation or discussion of first principles. This tendency can be observed in the book in question. Apart from a number of definitely inaccurate statements, such as "the engagement of meshing cycloidal teeth, for example, is affected (*sic*) by pure rolling motion" (p. 2), it may be held that the book fails to convey, in many instances, that mental picture of what is really happening so necessary in intelligent design. The portion devoted to interference in gear teeth and methods of tooth correction is an early example—a large proportion of the matter (comprising a bare two pages of text) dealing with this far from unimportant question differs hardly at all from that contained in the 1911 edition of the American Machinist Gear Book. On the other hand, the author goes to the other extreme when dealing with internal gearing, and out of seventeen pages devotes more than twelve to a discussion of a system of internal gearing of very little interest to gear manufacturers and users, and, incidentally, does much less than justice to the possibility of the involute internal gear.

The field covered by gear design is, however, so wide that it is perhaps hardly fair to refer to those things with which the author has omitted to deal, or even to object that some aspects of gear design or performance might, to the advantage of many readers, have been covered with fewer generalities and more practical detail. With that in mind, however, one wonders why the producers reprinted, *en bloc*, at the end of the book, some sixty pages of tabular matter which, though distributed, is easy enough to find.

BOOKS RECEIVED.

Schedule of Private Car Specifications and Prices. London: The Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. Price 2s. 6d. net.

The Chemistry of Cement and Concrete. By F. M. Lea, M.Sc., and C. H. Desch, D.Sc. London: Edward Arnold and Co., 41, Maddox-street, W.1. Price 25s. net.

The Mechanics of a Locomotive on a Curved Track. By the late S. R. M. Porter, M.A. London: *The Railway Gazette*, 33, Tothill-street, S.W.1. Price 5s. net.

Diesel Engines: Excessive Lubricating Oil Consumption. By P. H. Smith. London: Constable and Co., Ltd., 10–12, Orange-street, W.C.2. Price 3s. 6d. net.

Petroleum: Twenty-five Years' Retrospect, 1910–1935. London: The Institution of Petroleum Technologists, Aldine House, Bedford-street, W.C.2. Price 7s. 6d. net.

Mechanics of Materials. By S. G. George and E. W. Rettger. London: McGraw-Hill Publishing Company. Ltd., Aldwych House, Aldwych, W.C.2. Price 21st. net.

British Industries and their Organisation. Second edition. By G. C. Allen, Ph.D. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 10s. 6d. net.

The Calculus. By H. H. Dalaker, Ph.D., and H. E. Hartig, Ph.D. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 12s. 6d. net.

The Deterioration of Haulage Ropes in Service. By S. M. Dixon and M. A. Hogan. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 1s. net.

X-Rays in Theory and Experiment. Second edition. By A. H. Compton, Ph.D., and S. K. Allison, Ph.D. London: Macmillan and Co., Ltd., St. Martin's-street, W.C.2. Price 31s. 6d. net.

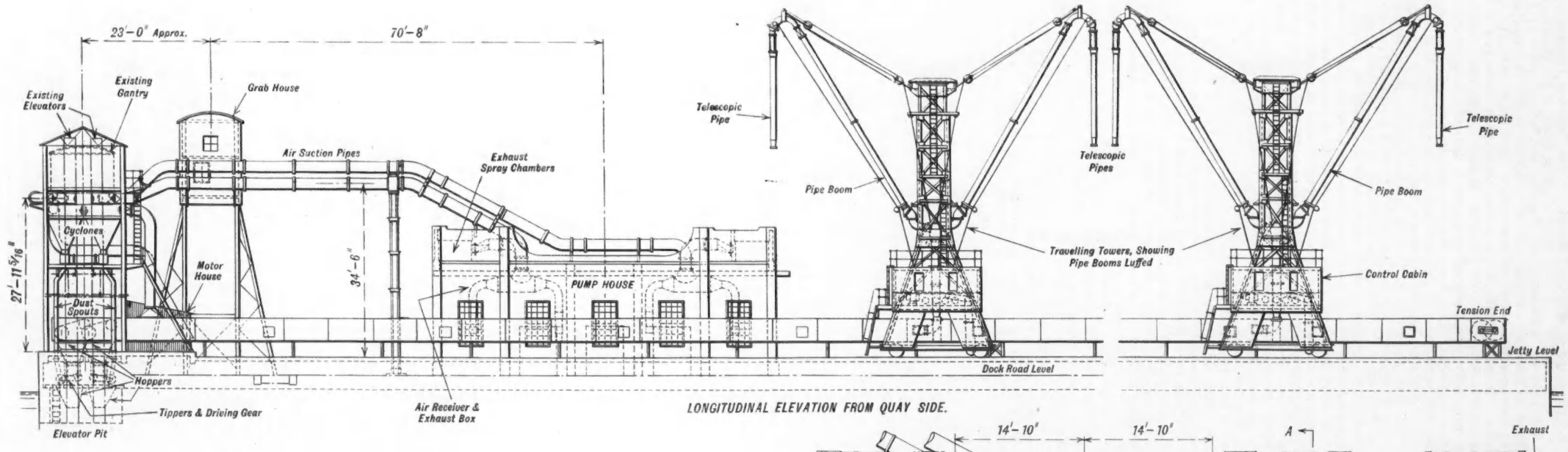
Schedule of Commercial Vehicle Specifications and Prices, Including Agricultural Tractors. London: The Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. Price 2s. 6d. net.

Report of the Departmental Committee on the Employment of Women and Young Persons on the Two-Shift System. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 1s. 6d. net.

TRAVELLING PNEUMATIC GRAIN DISCHARGING PLANT AT VICTORIA DOCKS, LONDON

HENRY SIMON, LTD., STOCKPORT, ENGINEERS

(For description see opposite page.)



280-Ton Travelling Pneumatic Grain Discharging Plant.

WE recently inspected at the Millenium Flour Mills of Spillers, Ltd. (W. Vernon and Sons' Branch), Victoria Docks, London, an improved type of travelling pneumatic grain discharging plant, which was specially designed and built to meet the owners' requirements by Henry Simon, Ltd., of Cheadle Heath, Stockport. The installation is of interest, not only on account of the new features it embodies, but because of the ingenious way in which the design was adapted to meet plant operating conditions, and the steps which were taken to erect the plant and bring it into service in the shortest possible time. It had to be erected and put to work without interfering with the existing intake plant, which comprises a Spencer ship elevator having a designed capacity of 120 tons per hour and a Simon auxiliary pneumatic cleaning up plant with two intake points having a total capacity of 70 tons per hour.

THE NEW PLANT.

The new discharging installation we are describing is arranged in two distinct units and has a normal intake capacity of 240 tons per hour. The pumps and the driving motors, however, have been rated for a higher capacity, so that when the discharging plant is required to fit in with the existing silo machinery it can, when fully at work under the best conditions, deal with capacities up to 280 tons per hour. The capacities above referred to are calculated on a basis of grain at 60 lb. per bushel.

PNEUMATIC PLANT DISCHARGING GRAIN FROM S.S. "ARTEMISIA"

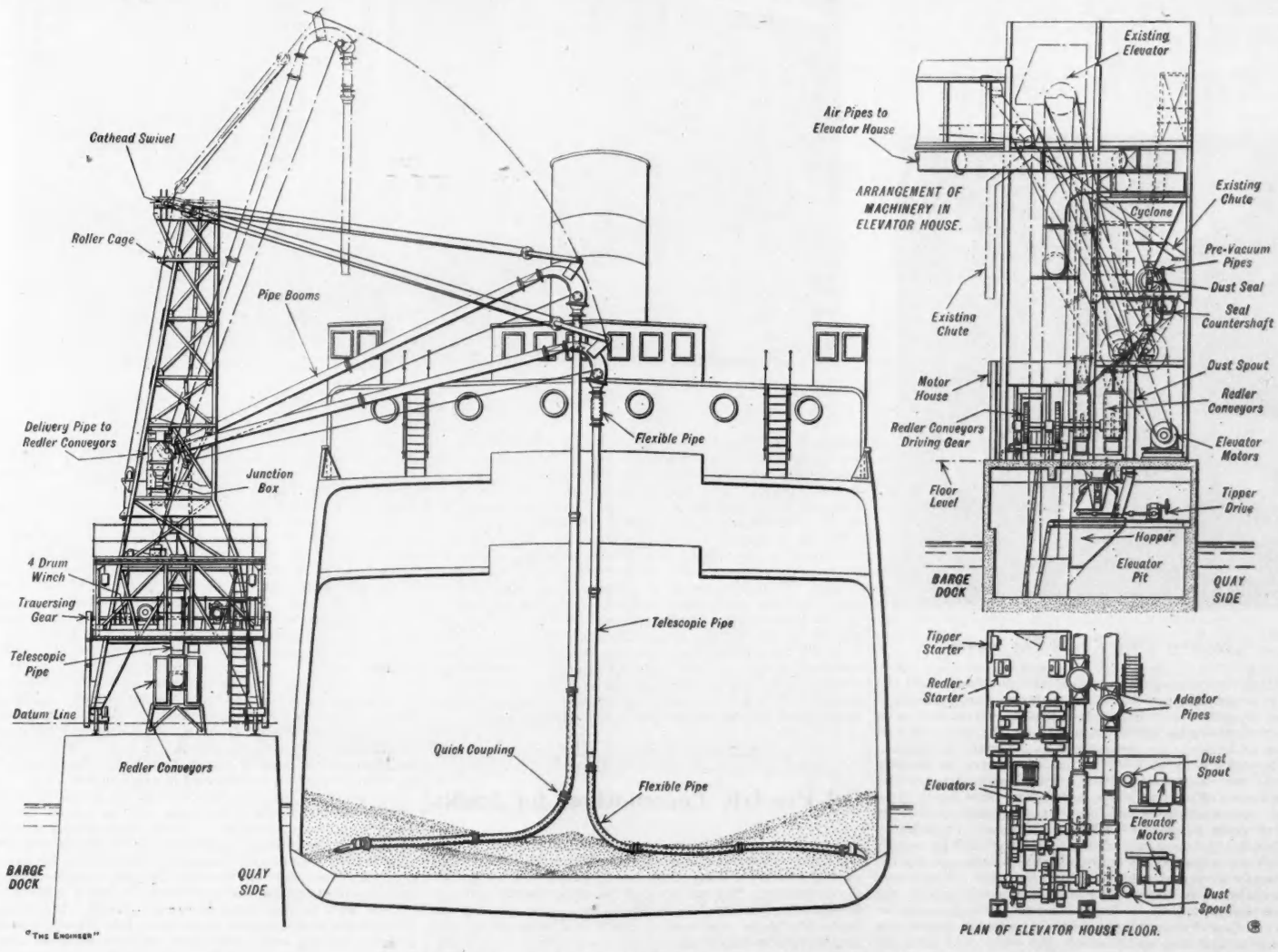
On page 92 we show two views of the new plant discharging grain from the steamer "Artemisia." The drawing reproduced on the opposite page and that below indicate the general lay-out of the installation and give some details of the pumps and conveyors, the two travelling intake towers, and their pipe booms. In preparing the design account had to be taken of the fact that the new plant had to be erected on the existing concrete jetty, which is entirely surrounded by water and lies between the quay and the barge dock, as shown on page 96. A further factor influencing the design was that the conveyor bands existing within the jetty could not be employed on account of possible dampness and dirt. It was also desired to make use of the two existing travelling towers carrying pipe booms, which were arranged on the quay, one on each side of the ship elevator, as shown in the drawings and engravings reproduced herewith.

Messrs. Spillers decided to adopt the Simon patented system of pneumatic conveying, which made it possible to utilise in the new plant the existing towers, which were strengthened to carry heavier pipe booms. Redler type conveyors were erected on the top of the jetty. By this means it was possible to carry forward the new work without interfering in any way with the existing belt conveyors and the ship elevator intakes. With the system adopted a further advantage was that there was no operation required on the towers and no grain receiver on the quay. The work now to be done simply meant building two new pipe booms on the existing intake towers, together with the necessary winches; the strengthening of the towers and the erection of two closed air-tight trunks along the jetty, each containing a Redler conveyor, the conveyors being under vacuum at the same time as the intake pipes. These air-tight conveyors were carried underneath the existing plants and were connected up to the existing elevator house while discharging with the old plant was still taking place. The pipe booms deliver the grain directly to the conveyors and the air passes on and is tapped from the conveyor and passed through cyclones, after which the vacuum pumps on the mainland deal with it. The particular construction adopted further avoided putting too much weight on the existing jetty.

One of the new intake plants was connected up during a week-end and one of the old ones remained, while during a later week-end the second plant was connected and the old plant put out of commission. The new plant was started up twelve months ago and it has remained in continuous and very satisfactory service ever since.

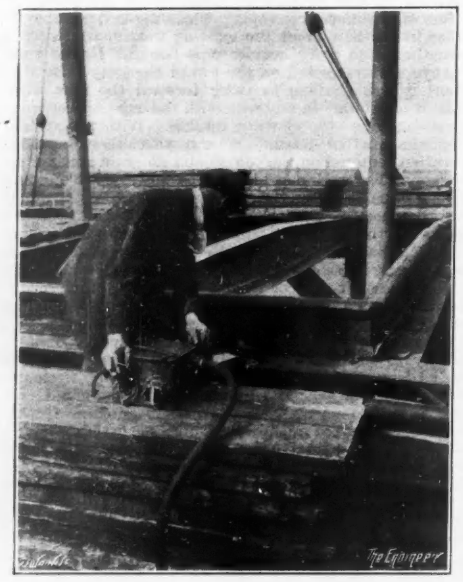
As our illustrations show, the main pumping plant is placed in a special pump house which was built between the side of the barge dock and the railway on the mainland. It is a reinforced concrete structure with two towers, one at either end, and is clearly shown in the lower view reproduced opposite. On the roof there are two exhaust chambers, which comprise a bed of granite chips with a water spray and form an effective filter grid system.

The pumping plant consists of two sets of double 14A pumps with a stroke of 14in. Each pair of cylinders is coupled together on a common crank shaft, which is driven by a motor through double reduction gearing. The motor shaft is carried in two outer bearings with a flexible coupling between the gear and the first bearing, the gear



ARRANGEMENT OF PNEUMATIC GRAIN DISCHARGING PLANT

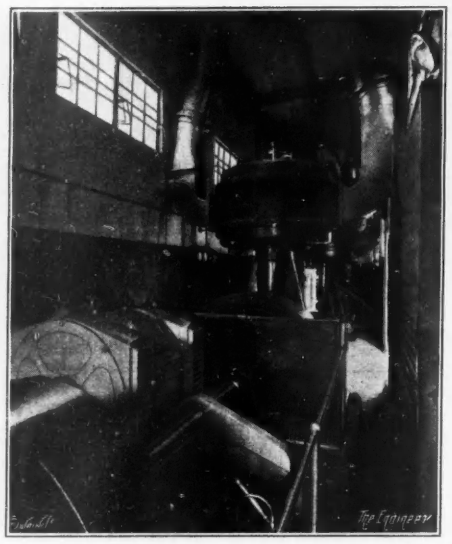
itself being carried on the shaft between the two bearings. The pumps and motors are mounted on a common cast iron bed-plate supported on the concrete foundations. There is an automatic group oil pump and filter, which supplies oil to all bearings and running parts. The pumps follow the standard Simon practice and operate with a high efficiency on a small pressure or low vacuum of 7in. to 12in. of mercury. They are of the double-acting reciprocating pattern with the multiple suction and delivery valves arranged directly above and below the piston. The valves are easily accessible and are secured by dogs and screws which project through the air chamber to the outside of the pump. Each cylinder is jacketed and is so divided that a suction and exhaust branch is formed, one on each side of the cylinder. The cylinders are supported on A type



CONTROLLER IN USE ON DECK OF SHIP

columns and the main bearings are ring lubricated in addition to the automatic pressure lubrication. The crosshead is of the double slipper pattern with loose shoes for adjustment, and the top end bearing is of the locomotive type with marine type bottom end bearings. The piston-rod carries an extension passing through a tail rod guide, and the piston rings are of the dry lubricated type, a graphite lubricant being employed. The driving motors, each of 170 b.h.p. output, are, we noted, made by Lancashire Dynamo and Crypto, Ltd., and are complete with automatic starters, which can be conveniently operated either from the jetty or from the weigh room. The gears were supplied by Turbine Gears, Ltd. The whole of the electrical wiring was carried out by the staff of Spillers, Ltd.

The main air pipes, which are of welded steel, are carried along the mainland on steel supports and pass under-



VACUUM PUMPS IN PUMP HOUSE

neath the existing gantry joining the mainland with the jetty, where they are connected with two steel cyclones of large capacity equipped with adjusting valves and with rotary discharging seals and spouts for the dust, all dust being returned to the system and mixed with the grain.

The travelling towers on the quay are, as already stated, the existing structures strengthened to carry two pipe booms of the swivelling, luffing, and telescoping type. Each travelling tower can be electrically traversed along the quay at a speed of 50ft. per minute. In order to facilitate the traversing of the tower the trailing supply cables are mounted on spring drums, which provide the necessary give and take in either direction. The tower structures each carry a winch house containing the traversing gear with its crane type motor and controller and a four-drum winch with a selector panel, so arranged that the operator on the ship can work the winches and telescope the booms from the top of the ship's hold, thereby providing a fully automatic control from a point giving a full view of the discharging operations.

As the drawings show, there are two luffing pipe booms, each provided with a telescopic pipe, thereby giving four movements for the manipulation of the grain nozzle in the ship's hold. Previously the control of the booms and pipes has been carried out from a cabin on the pneumatic plant structure, but in the plant we are describing the complete control is from the deck of the ship itself from the one small master controller fitted with a selector drum and an operating crank, a view of which we give in Fig. G.

The controller is placed on board at a convenient spot, and any motion required can be obtained by first of all selecting it on the drum and then using the crank handle to "raise," "lower," or "telescope," as required. Electric brakes and limit winches come into play automatically and give safety as well as convenience in operation.

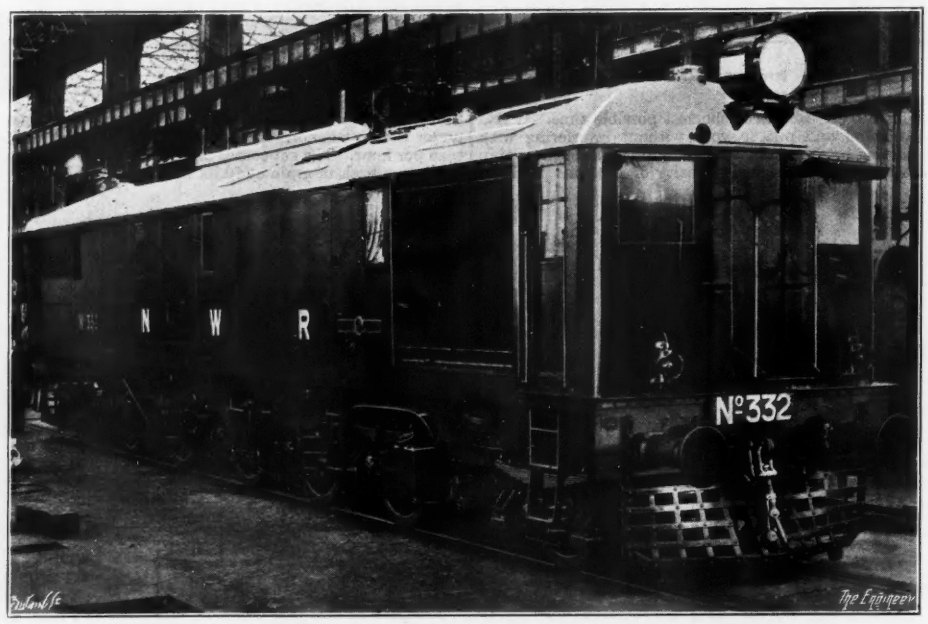
The master controller and the system of connections are so designed that should the operator on board leave the controller the operation is stopped. If a cable is cut and the strands broken or is short circuited to earth the plant is immediately stopped. The design of the controlling mechanism is such that the selector drum cannot be changed from one winch to another unless the winch is first stopped. All possible contingencies are thus well covered and the control gear made as fool-proof as possible.

Each travelling tower is equipped with flexible and telescopic pipe connections to the air-tight conveyors, which can rapidly be connected at 15ft. pitches to the conveyors, so that the conveyors can be used with either travelling plant. They are fitted with windows so that the grain can be seen in transit.

The air-tight conveyors consist of a rectangular heavy steel box mounted on steel supports along the centre of the jetty, in the side of which, at 15ft. pitches, are provided cast iron inlets with quick coupling flanges, at the top to which the travelling towers can be connected. When the grain is dropped into the trunks, the Redler conveyor carries the material along the bottom of the trunking to the intake house, where it is extracted by a standard "Simon" tipper electrically driven and provided with special mechanism to prevent stoppages which might be caused by any foreign matter in the grain. After leaving the tipper the grain is delivered to the two existing bucket elevators. The tippers are driven each by a 3 b.h.p. motor with Renold driving chains and oil-tight worms provided with a crank disc for oscillating the tippers.

Each of the enclosed Redler conveyors is driven by a 35 b.h.p. motor through a train of gearing arranged in the existing intake plant clear of the existing elevators, the motors being placed in a separate house at the outside of the intake shed. The dust seals below the cyclones previously referred to are driven from the existing line shafting in the intake house. The whole of the new plant is so designed that it can be automatically started and stopped either from the jetty or from the weigh room in the silo.

We have referred briefly to some of the novel features embodied in the plant, but this description would be incomplete without some reference to the performance figures. With the consent of Spillers, Ltd., we are able to state that the guaranteed power consumption was given by the builders as 0·9 kW per ton per hour for the end nearest to the intake house, and for the far positions 0·95 kW per ton per hour. At the official test the figures obtained were 0·86 and 0·93 kW per ton respectively, while on a special test arranged under perfect conditions a figure of 0·78 kW per ton was actually obtained, which speaks well for the economical working of the plant.



1300 H.P. OIL ELECTRIC LOCOMOTIVE

Oil Electric Locomotives for India.

THERE have just been shipped from the Tyne two of the most powerful Diesel-electric locomotives yet built in this country. They have been constructed by Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., of Scotswood Works, Newcastle-on-Tyne, for the Indian State Railways, and one of them is illustrated by the accompanying engraving.

These engines, each of 1300 h.p., measuring over 70ft. in length, and weighing 117 tons, have been ordered for the mail train services of the North-Western Railway. They are intended for the 780-mile run across the Sind Desert between Lahore and Karachi, and will haul the important daily mail train which serves a great part of the irrigated district of the Punjab.

These locomotives were ordered by the Indian Railway Board to demonstrate the advantages of a Diesel locomotive in waterless desert country, and with a view to obtaining experience which could be applied to the construction of new lines through desert country—such as the projected Bombay-Sind connection, which will probably be built to connect Bombay directly with Karachi, and which, it is anticipated, would be equipped entirely by such locomotives at great saving in capital cost, both for locomotive power and for engine sheds and other necessary plant on the lines. They are designed to haul a train of fifteen heavy coaches weighing 600 tons at a sustained speed of 60 m.p.h., and will run the whole distance of 780 miles between Lahore and Karachi without refuelling or shed attention. For this purpose two units will be coupled together and operated by one engine crew. The fuel tank capacity of 5 tons on each locomotive is, in fact, sufficient to run such a train 1400 miles. Thus the time at present lost on this run with steam locomotives in taking in water, coal, and in changing engines at intermediate running sheds can all be eliminated.

Special provisions have been made to cope with the severe climatic conditions, as the locomotives will have to operate in a shade temperature sometimes exceeding 120 deg. Fah., and be subject to dust and sand storms in the Sind Desert. All parts of the locomotives are, therefore, constructed to be dustproof and special air-filtering arrangements are provided for the engine and other power equipment. A double roof is provided to protect the driver from the sun, together with sun louvres and an electric fan.

The machinery is so designed that the locomotives can either haul high-speed passenger trains or be used on very heavy freight services, so their sphere of usefulness will be much greater than that of steam locomotives.

The arrangement of the locomotive with three rigid axles and two bogies was chosen to give good riding qualities at high speeds, in either direction of travel, whilst providing a short rigid wheel base so that the locomotive need not be restricted to the main routes where curves are of large radius. At the same time, as the locomotives are also intended for goods working, four driving axles are obtained by motoring one of the bogie axles. The combined tractive effort of two of these units amounts to 76,000 lb., which is far in excess of any steam locomotive at present in service. The locomotives have been built to the inspection of Messrs. Rendel, Palmer and Tritton.

The driving wheels are 48in. diameter, and the bogie wheels 36in. diameter. The design of the bogies follows Indian State Railway steam locomotive practice; both bogies carry large diameter flat pivots with bronze liner plates, the pivot in the case of the motor bogie being slightly offset to give equal weight distribution. Side movement of both bogies is allowed, so that the rigid wheel base is limited to the 14ft. 3in. wheel base of the three rigid axles. This movement is controlled in one case by helical springs, and in the other by laminated springs, and this, in conjunction with the unsymmetrical wheel base, ensures that lateral oscillation is quickly damped out.

The main and auxiliary generators are of Laurence Scott design, and the four axle suspended motors are of Crompton-Parkinson manufacture. Control apparatus was supplied by both these firms to Armstrong, Whitworth patents and specifications, and incorporates the automatic constant-power control which the latter firm employs on all its larger locomotives and motor coaches.

In view of the fact that the gauge of the Indian railways is 5ft. 6in. the locomotives could not be moved on the English railways, and they were consequently loaded directly at the makers' wharf on to one of the specially constructed "Belship" steamers and will be lifted off again at the port of Karachi by the steamer's own cranes, which are specially equipped for such a purpose.

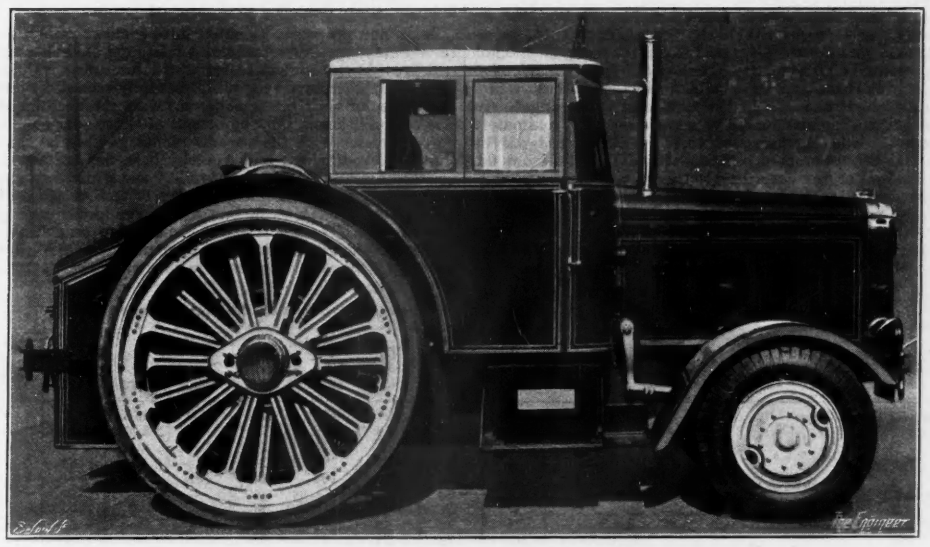
This will be the third railway to which Armstrong, Whitworth have supplied large main line Diesel locomotives for hauling heavy main line trains, the others being the Buenos Ayres Great Southern Railway, which has

had a number of these units running for some years, and the Ceylon Government Railways, which has recently put two somewhat smaller locomotives into its important mail services between Colombo and the Talaimannar Ferry to the mainland of India. The following table gives a few particulars :—

Power of main and auxiliary engines ..	1,300 b.h.p.
Weight in working order	113 tons
Maximum axle load	17 tons
Tractive effort of each unit	38,000 lb.
Maximum speed	70 m.p.h.
Length over buffer beams	52ft. 6in.
Fuel capacity in mail service	1,600 miles
,, ,, in goods working	1,100 miles

Oil-Engined Showman's Road Locomotive.

THE road locomotive which we illustrate has recently been built by John Fowler and Co. (Leeds), Ltd., for the proprietors of a travelling fair. It is designed to perform both the duties of a tractor on the road and of an electric power plant on the fair ground. It weighs in working order 15½ tons, and the power plant comprises a six-cylinder Fowler oil engine which develops 80 h.p. at a speed of 1100 r.p.m., directly coupled through an extension shaft to a Mather and Platt 450-ampère, 110-volt dynamo. For transport purposes the power of the engine is transmitted to the road wheels through a multi-plate clutch and primary and secondary gear-boxes. One box gives three speeds and a reverse and the other two speeds, or six forward speeds in all. The driving wheels are of the traction engine type, shod with twin endless solid tires, and are 6ft. 9in. diameter by 18in. wide. The steering wheels are 3ft. 6in. diameter by 9in. wide and are fitted with pneumatic tires. The tractor carries sufficient fuel oil for 80 to 100 hours' work. The steerage is on the Ackermann principle, and for haulage purposes there is a winding drum with 75 yards of steel wire rope. Hand and foot brakes are provided on the transmission system and screw-operated shoe brakes on the rear wheels. An improved system of springing is applied to the rear axle. The electrical equipment includes a starter for the engine, a switchboard with ammeter and voltmeter, and generator field regulator fitted in the cab. The overall length of the machine is 19ft., width 7ft. 7in., and height 10ft. 2in.

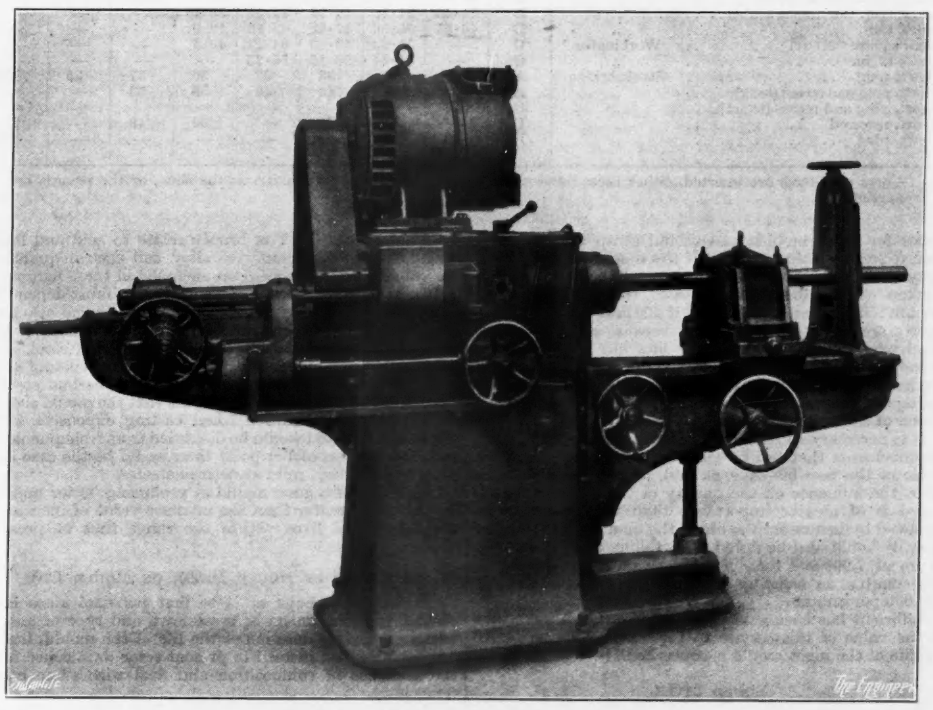


SHOWMAN'S ROAD LOCOMOTIVE

A Boring Machine for Axle Brasses.

THE illustration which we reproduce herewith represents a boring machine which has been designed specially for boring the axle brasses of carriages and wagons by George Richards and Co., Ltd., of Broadheath, near Manchester.

As will be seen, the main frame takes the form of a box-like pedestal, on one side of which there is fixed a bracket to carry the tail end of the boring spindle. On the opposite side there is a set of vertical slides for the knee carrying the workpiece, which can be raised or lowered to the extent of 6in. by a large diameter screw and hand wheel. The maximum distance from the top of the knee to the centre of the spindle is 16¼in. The brasses are mounted in a fixture, which can be slid along the knee by a hand wheel, and two brasses are bored together. The fixture is provided with gauge blocks to suit the different sizes of brasses to be dealt with, and they are held in place by a cover plate and swing bolts. The knee also carries a steady rest for the outer end of the boring bar. The boring spindle, which is 2½in. in diameter, has a traverse of 18in. and the nose is bored No. 5 Morse taper. It is driven at one of four speeds ranging from 59 to 300 r.p.m., and has four feeds of 16, 25, 40, and 64 per inch. Fine and rapid hand adjustments are also provided through conveniently placed hand wheels. The machine is driven through Tex-ropes by a 5 h.p. motor placed above the gear-box, and can be started and stopped with a friction clutch without it being necessary to stop the motor. The main bearings are continuously lubricated by a gear-driven oil pump fixed in the machine base.



BORING MACHINE FOR AXLE BRASSES

The Institute of Metals.

THE thirty-seventh annual meeting of the Institute of Metals will be held at Newcastle-upon-Tyne from Monday, September 9th, to Thursday, September 12th, 1935.

The meeting will open on Monday evening at 7.15 p.m. in the King's Hall, Armstrong College. Dr. H. W. Brownsdon will give the Fourteenth Autumn Lecture, and has chosen for his subject "Metal Melting: Its Effect on Quality." A general discussion will follow. At 9.45 p.m. the delegates and their ladies will meet informally in the University Union, College-road, where light refreshments will be served. On Tuesday at 10 a.m. the Lord Mayor will hold a civic welcome in the King's Hall, Armstrong College. The general meeting will start at 10.30 a.m. in the Mining Lecture Theatre, when the following papers will be presented for discussion :—"Metal Losses in Melting Brass and other Copper Alloys," by Dr. Maurice Cook; "Observations of the Porosity and Segregation of Two Bronze Ingots," by Mr. N. P. Allen and Mr. S. M. Puddephat; "The Properties of Some Special Bronzes," by Professor D. Hanson and Mr. M. A. Wheeler, and should time permit, "An X-Ray Investigation of Certain Copper-tin Alloys," by Professor E. A. Owen and Dr. John Iball. Members will take part in the following visits, leaving College-road at 2 p.m.:—Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd.; the Dunston Power Station of the North-Eastern Electric Supply Company, Ltd.; Vickers-Armstrong, Ltd., and ladies' visit to Cremona Toffee Works. The Lord Mayor and Lady Mayoress will hold a civic reception and dance at the Old Assembly Rooms from 8.30 p.m. to midnight.

The meetings will be continued in the Mining Lecture Theatre on Wednesday at 10 a.m., when the following papers will be presented for discussion :—"The Interrelation of Age-hardening and Creep Performance; Part I, the Age Hardening of Nickel Silicon-Copper Alloys," with an Appendix on "The Relationship of Time, Temperature, and Concentration as Factors in Age Hardening," by Dr. C. H. M. Jenkins and Mr. E. H. Bucknall; "An Investigation of the Nature of Creep Under Stresses Produced by Pure Flexure," by Mr. H. J. Tapsell and Mr. A. E. Johnson; "Note on the Effect of Interrupted Straining on the Elongation of Lead," by Mr. J. C. Chaston; "Corrosion Below Discontinuous Oxide Coatings with special reference to Magnesium," by Mr. K. G. Lewis and Dr. U. R. Evans; "The Protection of Magnesium Alloys Against Corrosion," by Mr. H. Sutton and Mr. L. F. Le Brocq; and should time permit, "Electron Diffraction Examination of Protective Films Deposited on Magnesium and Magnesium Alloys by the R.A.E. Dichromate Process," by Mr. H. G. Hopkins, and "Alloys of Magnesium: Part III, Constitution of the Magnesium-rich Alloys containing Aluminium and Cadmium." The following visits have been arranged for the afternoon :—The North-Eastern Marine Engineering Company, Ltd.; C. A. Parsons and Co., Ltd.; A. Reyrolle and Co., Ltd., and the Wallsend Shipyard of Swan, Hunter and Wigham Richardson, Ltd. A dinner will be held in the evening at the Royal Station Hotel at 8 p.m. An all-day excursion has been arranged for Thursday, September 12th, 1935. The following papers will not be read at the meeting, but correspondence is invited by post :—"X-Ray Study of Copper-Silver Alloys," by Professor E. A. Armstrong and Dr. Joseph Rogers; "The Determination of Certain Phase Boundaries in the Silver-zinc Thermal Diagram by X-Ray Analysis," by Professor E. A. Owen and Mr. I. G. Edmunds; "Note on the Failure of a Gold Fuse in Contact with Nickel-Chromium Alloy," by Mr. M. C. Caplan; "Production of Powdered Alloys of Low Melting Point," by Mr. R. W. Rees; and "Note on the Tarnishing of Liquid Metals as Studied by X-Rays," by Dr. Hugh O'Neill and Dr. G. F. Farnham.

SIXTY YEARS AGO.

WHILE the brake trials on the Midland Railway in 1875 furnished much enlightenment on the application and working of continuous brakes on railway trains there were some who were still not satisfied that the use of brake blocks was the only practical or the best method of bringing a train to rest. A correspondent signing himself "J.M." and writing from Dundee discussed the subject in a letter to the Editor which we published in our issue of July 23rd, 1875. His object was to call attention to a system invented by Mr. Huntley known as the valve regulator which, he claimed, "had been proved to be the best contrivance ever discovered for stopping a locomotive engine." Mr. Huntley, he said, was no mere schemer. He had had experience as a practical engineer for more than half a century and at an advanced age was still as bright and enthusiastic as ever. For nearly ten years he had been in the service of Robert Stephenson and Co. (*sic*) of Newcastle-on-Tyne "where he erected the first locomotive that ever drew a passenger train and ran it on the Stockton and Darlington Railway in 1825." Mr. Huntley's system made use of a circular sheave acted upon by the straps of the excentric and regulating the lead as well as the travel of the slide valves at the will of the driver. By means of this arrangement the driver, it was stated by our correspondent, could in a single moment "cause the full force of the steam to act as a holding power resisting the onward progress of his train without reversing the engine." The piston forced the steam back into the boiler for 85 per cent. of the stroke when compression took place up to 95 per cent., the steam thereafter exhausting as regularly as if the engine were propelling. The wheels could be held after three or four strokes of the piston. Our correspondent argued that to reverse the engine on short notice by means of the ordinary link motion was impossible. He gave an instance of disaster which had been caused by such a procedure. The old wooden bridge across the Tay at Perth was under repair and was being worked single line. The driver of a goods train from Dundee passed the signal to stop before coming on to the bridge and encountered a number of

passenger carriages which were being pushed across the bridge in the opposite direction. He reversed the engine and leaving the steam on jumped, with his fireman, off the footplate. This action did not however avoid a collision with the passenger carriages in which the station-master at Perth was riding. That official was killed. The engine being reversed and unattended gathered speed and running backwards was stopped only after a large number of wagons on the line had been destroyed.

British Standards Institution.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

THE SAMPLING OF COAL TAR AND ITS PRODUCTS.

No. 616—1935. In the course of the Institution's work in the preparation of B.S. Specifications for Creosote the need for a recognised method of sampling became apparent. A number of B.S. Specifications for other coal tar products were also in course of preparation by other Committees, and it was felt that the establishment at an early date of a standard method of sampling was necessary, in order that the individual specifications might make reference to it. The Specification for Sampling of Coal Tar and its Products is dealt with in four sections covering general precautions, design and use of apparatus, general procedure for sampling of packages, tanks and pipe lines. A further section is devoted to the method of drawing the bulk sample and the preparation from the bulk sample of the final sample. The sampling of creosote oils with an aqueous layer at the bottom or top is included for general information and guidance in an appendix. The Committee responsible for the preparation of this specification has explained in the preface that no specification, however explicit, can take the place of judgment, skill, and experience, and that the directions given are intended primarily to supplement such experience, and to serve as a guide to the selection of the best method.

EMULSIONS OF ROAD TAR AND OF ROAD TAR-ASPHALTIC BITUMEN MIXTURES.

No. 618—1935. The specification is the result of the work of a Committee on which the engineers and surveyors of municipal and county authorities, Government departments, and the societies and associations interested in road building were represented. The initial draft was prepared by the British Road Tar Association, and continual assistance has been afforded by that organisation throughout its progress in Committee working in close co-operation with the Road Emulsion and Cold Bituminous Roads Association. It is the first British Standard Specification for a cold road dressing incorporating tar.

WROUGHT ALUMINIUM AND ALUMINIUM ALLOYS.

The following British Standard Specifications for Aircraft work have just been issued by the British Standards Institution :—

L. 36, *Aluminium Rivets, and L.* 37, *Aluminium Alloy Rivets* (*Duralumin*).—These specifications replace the Air Ministry Specifications D.T.D. 148 and 110 respectively. Each specification is divided into two sections, one covering the rods and wires for rivets and the other the finished rivets.

4 *L* 1, *Aluminium Alloy Bars, Extruded Sections and Forgings* (*Duralumin*), *and L* 39, *Aluminium Alloy Bars for Machining* (*Duralumin*), *Over* 3*in. Thick*.—The 4 L 1 Specification is a revision of the B.S. Specification 3 L 1 and now includes a section on forgings, which replaces the Air Ministry Specification D.T.D. 18 C. The section on bars for machining in the 4 L 1 Specification is limited to bars not exceeding 3in. thick, and the new Specification L.39 covers bars for machining over 3in. and up to 6in. thick. The tensile test properties of the material are as follows :—

	4 L 1. Bars for machining (not exceeding 3in.). Extruded sections. Forgings.	L.39. Bars for machining (over 3in. and up to 6in.).
0·1 per cent. proof stress (tons per sq. in.)	15 (min.)	12 (min.)
Ultimate tensile stress (tons per sq. in.)	25 ,,	22 ,,
Elongation (per cent.)	15 ,,	15 ,,

L 42, *Aluminium Alloy Drop Forgings, Including Pistons and Cylinder Heads* (*Hiduminium R.R.* 59).—This specification replaces the Air Ministry Specification D.T.D. 132. The tensile test properties of this material are as follows :—

Ultimate tensile stress (tons per sq. in.)	25 (min.)
Elongation (per cent.)	6 ,,

These specifications are obtainable at 1s. 2d. each, post free, or 5s. 2d. the set.

THE returns prepared by Lloyd's Register of Shipping show that the gross reduction in the mercantile marine of the world from all causes during the quarter ended December 31st last was represented by 191 vessels, of 498,035 tons gross, of which 47 were British and 144 foreign. Of this shipping, 65 vessels, of 85,785 tons gross, were lost in consequence of casualty or stress of weather, 15 being British and 50 foreign ; 126 vessels, of 412,250 tons gross, were broken up, condemned, or lost otherwise than in consequence of casualty or stress of weather, of which 32 were British and 94 foreign.

Some Notes on Ingot Moulds.

By T. SWINDEN, D.Met. (Member), and G. R. BOLSOVER, F. Inst. P.*

MOULD COSTS.

BY far the greatest proportion of the world's steel production is cast in the form of ingots for subsequent manipulation by rolling or forging. A very rough estimate indicates that the annual consumption of ingot moulds is of the order of 100,000 tons. Practically the whole of this is in the form of cast iron, and therefore the subject is of considerable interest to the ironfoundry industry. At the same time, it is necessary to keep in mind that the ingot mould is merely a tool required to give the desired shape to the steel ingot, and its value is to be considered under two headings : (*a*) The cost per ton of steel produced, and (*b*) the influence of factors connected with the mould on the quality of the resulting ingot.

As regards the cost per ton of ingots, in a recent paper by Mr. J. Blakiston, before the Middlesbrough Branch of this Institute, it was stated that the value of castings of all kinds used in the ultimate production of a ton of semi-finished steel was approximately 10s. per ton, and that the ingot moulds, bottoms, and slag ladles accounted for from 2s. to 5s. per ton.

Confining attention to ingot moulds, F. W. Morawa —*Stahl und Eisen*, 51 (1931), Vols. 40 and 41, pages 1221–28 and 1256–63—stated that the cost of moulds represented only some 3 per cent. of the cost of conversion in the steel-making shop, which conversion cost represented about one-fifth of the total cost of the ingot. In the authors' opinion, these values are very approximately correct. The ingot mould costs in the plants of the United Steel Companies, Ltd., varied in 1934 from 9d. to 1s. 7d. per ton, according to the type of plant and steel being produced. The cost of bottoms varied from 1½d. to 4½d. per ton.

As a further approximate guide on this subject, if it is assumed, say, for rolling ingots that the weight of the mould is similar to that of the ingot produced and present prices for ingot moulds and mould scrap are accepted, then it can be estimated that if the mould gives a life of forty casts, the cost per ton of ingot will be about 1s. 6d. per ton. If the life be eighty casts, the cost will be 9d. per ton ; if 100 casts, 7·2d., and if 200 casts, 3·6d. These figures are not strictly accurate, because other costs are involved if moulds give a short life, but it is sufficient to indicate that if, for example, the life of an ingot mould can be increased from 100 to 200 casts, other things remaining equal, this represents a possible economy to the steel maker of the order of 3½d. to 4d. per ton.

It is necessary to recognise, therefore, that the possible improvements that can be made have a limitation in the value of the possible savings, and, as will be referred to later, the influence on the quality of the steel ingot produced is of greater importance than the saving to be achieved by increasing the life of the mould. At the same time it should also be noted that, taking an approximate figure of 7,000,000 tons of ingots produced annually in this country, an economy of 1d. per ton represents nearly £30,000 per annum.

Sufficient has been said perhaps to establish some idea of the value of this service to the steel maker so far as the life of the ingot mould is concerned.

MOULD LIVES.

The first essential in assessing the value of ingot moulds is to have an accurate system of recording data. In works of the United Steel Companies, Ltd., it has been the custom for several years to keep a complete record of the life of every mould so that the results can be analysed by "maker," "size," "type," "composition," &c., and as regards the moulds which are made within the organisation, additional data as to iron mixture, cupola practice, casting temperature, analysis, &c., are tabulated.

Each month is recorded the life of every mould scrapped during that period, the cumulative average for the period is reported and also the average for the preceding half-year. In Table I are given the six monthly average figures for a selected number of mould types at the various branches. The description will probably be sufficient to indicate to those interested the type of mould referred to, but if required the authors will be happy to provide actual sketches of each of the moulds in question. An analysis of these figures produces some interesting observations. It is seen that over a period of time in some shops the lives vary to a considerable extent, although it may be said, speaking generally, that there has been a general trend towards improvement ; in some cases this has been quite marked. There are cases where one make of mould during a certain period has given consistently low results, while another make of similar mould has given much better results. This definitely indicates that the quality of the mould is primarily responsible. On the other hand, it will be noted that in certain periods there has been a tendency for all makes of moulds to give lives lower than average, and the general explanation in such cases is to be found in a change in shop conditions necessitating using the moulds with greater frequency. The authors have carried out specific experiments on this point, and the indications have been that conditions which reduce the temperature to which the moulds are heated have a definite tendency to improve their life.

It is not proposed to enter into a closer analysis of these figures at the moment, but it is suggested that they will provide a useful basis for discussion and a valuable record in that they do represent carefully recorded figures in a series of six melting shops operating under different sets of conditions. For the benefit of those who may not be conversant with the various plants, it may be stated that the Frodingham and Appleby branches are engaged primarily in the production of mild basic structural steels. The figures for the Templeborough branch relate essentially to mild basic steel, but with a proportion of high-carbon steel. The ingots at the Rotherham branch are of acid steels of high-carbon and alloy quality. The Workington branch make acid Bessemer steel of various types, while the values from the Fox branch relate to acid and basic open-hearth steel, mainly of alloy and special qualities. No values for electric steel are included in these figures.

TABLE I.—*Six-monthly Average Lives of Ingot Moulds at the Various Works of the United Steel Companies, Ltd.*

Type of mould.	Branch.	Maker.	To Dec., 1934.	To June, 1934.	To Dec., 1933.	To June, 1933.	To Dec., 1932.	To June, 1932.	To Dec., 1931.	To June, 1931.
70 cwt. Tapered top	Frodingham	D	105	97	126	134	128	116	122	—
,, ,, ,,	,,	E	—	79	92	110	126	113	—	—
,, ,, ,,	,,	F	100	88	118	98	101	92	90	—
,, ,, ,,	,,	G	89	80	97	125	115	89	81	—
,, ,, ,,	,,	C	93	80	104	106	105	—	—	—
80 cwt. ,, ,,	,,	G	93	—	—	—	—	—	—	—
,, ,, ,,	,,	C	51	49	73	65	—	—	—	—
70 cwt. brick top	,,	D	98	99	28	—	—	—	55	—
6-ton ,, ,,	Appleby	G	45	31	17	11	—	—	—	—
6-ton long tapered top	,,	C	83	62	—	26	—	—	—	—
,, ,, ,, ,,	,,	G	—	—	39	32	35	41	40	25
6-ton long closed top	,,	G	72	79	39	—	—	—	—	38
,, ,, ,, ,,	,,	E	83	70	32	—	—	—	—	41
10-ton ,, ,, ,,	,,	D	84	71	20	—	—	—	—	—
,, ,, ,, ,,	,,	E	65	58	42	—	—	—	—	38
,, ,, ,, ,,	,,	G	82	67	—	—	—	—	—	—
10-ton brick top	,,	D	53	37	—	—	—	—	—	—
,, ,, ,,	,,	E	28	42	30	30	—	—	16	—
15-ton rammed top	,,	G	62	54	56	47	43	46	49	41
21in. S.C.T.	Templeborough	B	83·22	87·23	72·75	74·30	76·42	85·8	85·4	82·4
,, ,,	,,	G	76·77	77·61	82·69	81·03	80·90	89·7	96·0	79·0
,, ,,	,,	F	99·00	97·93	86·59	92·82	84·56	—	—	70·5
,, ,,	,,	H	79·00	90·27	79·68	76·05	—	—	—	—
,, ,,	,,	C	77·57	78·02	—	—	—	86·0	95·0	78·0
11in. octagon	Rotherham	B	52·66	33·33	50·00	53·0	30·4	29·29	42·5	43·6
17in. square centre run	,,	B	41·89	45·85	42·63	43·88	38·8	40·3	45·33	46·4
18in. × 19in. closed bottom	,,	B	68·43	57·54	59·50	48·0	47·0	36·2	53·25	53·1
14in. × 12in. sided open ended	,,	B	41·40	34·43	46·70	49·48	30·12	—	—	—
19in. × 12in. ,, ,, ,,	,,	B	46·51	56·56	47·92	45·20	19·0	—	—	—
19½in. square	Workington	C	—	54·23	43·63	54·27	45·5	—	—	—
21in. × 19½in.	,,	C	—	64·84	58·15	55·23	—	—	—	—
26-cwt. plug	Stocksbridge	A	40	37	33	32	30	37	35	13
38-cwt. plug and recess (long)	,,	A	47	41	43	48	59	53	—	—
38-cwt. plug and recess (short)	,,	H	38	39	—	—	—	—	—	—
38-cwt. recessed	,,	F	—	39	40	—	30	19	—	20
45-cwt. plug	,,	F	29	30	29	—	—	—	—	19

Where no figures are inserted, either these particular moulds were not in regular use at the time, or the records are incomplete.

MOULD METAL ON MOULD LIFE.

One ought perhaps to state first personal ideas concerning the mechanism of breakdown and type of failure which ultimately determines the life of the mould, but it has been decided instead to present some data concerning the influence of composition and deal with these other items later.

The authors propose to confine their attention meantime to iron moulds, and it is the fact that at least in many works hematite iron has been specified, having in mind the higher salvage value of the used moulds. Nevertheless, it has been suggested that a fairly pure hematite was a good choice apart from this, on account of its high resistance to thermal shock. It is not necessary at a meeting of foundrymen to outline the influence of the various elements normally found in hematite iron and describe the effect of the various elements on the structure and properties of the material. The authors have found—and this experience is, it is thought, in full accord with that of many

* Institute of British Foundrymen. Thirty-second Annual Conference, Sheffield, July, 1935.

other observers—that the composition can vary within fairly wide limits without any consistent effect on the mould life. In other words, moulds having abnormally good and abnormally bad lives are found to differ only very slightly in chemical composition. Far more importance is no doubt to be placed on the structure of the material, with particular reference to the form and distribution of the graphite carbon.

The authors have noted with interest the recent work of the Cast Iron Research Association in this direction, and look forward with great interest to the result of practical tests on the special type of iron which now promises to become available, having a high total carbon, a considerable proportion of which may be graphitic, but in a very fine and evenly dispersed form throughout the structure.

Uniformity of structure is no doubt also a very important matter, having in mind that a large proportion of moulds fail by cracking long before the surface is sufficiently deteriorated to warrant the mould being discarded.

A general statement of the analysis of the moulds that have been used by this company would be as follows:—Total carbon, 3·5 to 3·75; combined carbon, 0·3 to 0·6; manganese, 0·6 to 1·0; silicon, 1·9 to 2·3; sulphur, 0·03 to 0·05; and phosphorus, 0·03 to 0·045 per cent. There is a tendency at the present time to work towards a rather lower silicon—say, 1·7 to 1·9 per cent.—with manganese higher at 0·9 to 1·1 per cent. It is also a matter of uncertainty whether the low phosphorus previously specified is best from the point of view of mould life, some evidence being provided that a rather higher phosphorus—say, 0·06 to 0·08 per cent.—is to be preferred. In this direction it will be noted that some German moulds contained phosphorus in the region of 0·2 per cent.

Alloyed Cast Iron Ingot Moulds.

It is interesting to note that none of the special heat-resisting qualities of cast iron has fulfilled the early expectations that they might provide super-quality ingot moulds. There are still differences of opinion as to whether some of the low-alloyed iron moulds are worth while. Personal experience so far has been rather mixed; but, on the whole, the authors would say that they have no evidence to show that the addition of chromium or nickel is worth while. In one series of tests the addition of 0·5 per cent. chromium at Stocksbridge showed a definite improvement on thirteen moulds, the average life being sixty-three, as against an average of similar moulds without chromium of forty-five. A further set of moulds, having additions respectively of 0·25, 0·5, and 1·25 per cent. chromium, did not confirm the earlier results. Batches of experimental moulds containing 0·5 per cent. chromium were used at Templeborough and at Frodingham. The final reports were that there was no improvement in the life of the moulds.

Experimental batches of moulds containing 1·0 per cent. nickel showed no advantage; in fact, the results were inferior to those of the standard composition. There is, however, some indication that somewhat higher manganese would be advantageous, and moulds containing 1¼ per cent. manganese are under test at the present time.

The authors have examined the influence of the admixture of steel scrap, and also the influence of the proportion of scrap mould metal used. No advantage was gained by the admixture of steel scrap except in so far as this may be used to regulate the content of silicon. A careful series of tests on the use of mould metal indicates that under one condition of manufacture the best results were obtained with an admixture of 30 per cent. of mould metal.

Extensive trials have also been made comparing cupola-melted iron with a mixture of mixer metal and refined iron. The latter proved to be somewhat superior, but moulds made from all refined iron were no better than the standard cupola iron. The use of molybdenum has been advocated, but no convincing results are yet available. The same applies to certain other special alloys which, naturally, arise in one's mind.

The above comments are necessarily somewhat brief and sketchy, but they do tend to indicate what is felt to be the right line of progress, namely, that a most satisfactory and economical mould will be one which does not depend essentially on the addition of expensive special alloys, but on obtaining the correct structure in a suitable hematite iron. The subject has, of course, been referred to by many other writers, but it is not proposed to give a lengthy statement of other published data. The subject is having the attention of the Heterogeneity of Steel Ingots Committee, and has been referred to in several of their reports. Morawa (*loc. cit.*) makes a useful contribution to this subject, and Table II is reproduced from his paper. In the recent paper by Blakiston (*loc. cit.*) one is again told that, after the careful observation of over 250 moulds, it was found that the analysis, within reasonable limitations, had no influence on the subsequent life of the mould. Moulds of identical analysis gave 13 and 120 lives respectively. He suggests that the most suitable analysis is:—Total carbon, 3·50 min.; combined carbon, 0·50 max.; silicon, 1·80; manganese, 1·20 max.; sulphur, 0·03 max.; and phosphorus, 0·06 per cent. max. He makes an interesting statement that the best results are obtained by blending equal proportions of two different makes of hematite, one high and one low in silicon, together with small additions up to 6 per cent. of steel scrap.

The editorial in the *Foundry Trades Journal*, Vol. 52, February 28th, 1935, also draws attention to an interesting statement by Mr. J. Léonard, President of the Belgium Foundrymen's Association. First, that different types of moulds fail in different ways, concerning which it is hoped to say something later, and gave as his opinion that, as regards composition, the total carbon should be 3·5 per cent., manganese 0·4 to 0·5 per cent., with 1·7 per cent. of silicon, while further Continental research workers have standardised on 3·75 per cent. carbon and 1·2 per cent. silicon. Mr. Léonard also attaches considerable importance to grain size.

Mr. Blakiston refers to the much longer lives obtained on the Continent, mentioning figures for 4-ton moulds up to 400 casts. Morawa appears to regard 250 casts as a normal life. This matter has naturally had the authors' close attention. They believe, on the one hand, that in Continental practice, where such lives are obtained, moulds are continued to be used far beyond the point at which they would be scrapped in this country on account of the influence on the quality of the surface of the resulting ingot, but, nevertheless, there is good reason to believe that both from the point of view of the quality of the mould and the care taken in its use Continental practice on the whole is somewhat ahead of the average practice in this country. Some years ago, the authors obtained some moulds from Germany, and the results may be of interest. One batch obtained in 1930 had the following average composition:—Total carbon, 4·0; combined carbon, 0·6; silicon, 0·65; manganese, 1·15; sulphur, 0·014; and phosphorus, 0·23 per cent. These were not of a type on which strictly comparable results with existing types were obtainable, and therefore a further set of six moulds was obtained on the standard 21in. S.C.T. type in common use in the Templeborough plant. A complete analysis of each of the six moulds is given in Table III, together with the lives obtained and the type of failure. Attention is directed to the comparatively low silicon and the high phosphorus.

Table III.—*Composition and Life of German Moulds.*

Mould No.	T.C.	C.C.	Si.	S.	P.	Mn.	Ni.	Cr.
1	3·82	0·55	0·86	0·060	0·166	0·75	0·04	0·10
2	3·83	0·60	0·85	0·067	0·162	0·60	0·03	0·08
3	3·77	0·44	0·91	0·060	0·165	0·63	0·04	0·07
4	—	—	0·99	0·070	0·186	0·56	0·02	0·04
5	3·72	0·57	0·91	0·064	0·177	0·58	0·05	0·06
6	3·70	0·57	0·86	0·053	0·180	0·54	0·04	0·07

No.	Life.	Type of failure.
1	137	Cracked slightly after 132; kept in use until not safe to use further
2	159	Cracked-up corner of mould
3	102	Cracked-up corner of mould
4	138	Cracked-up corner of mould
5	127	Cracked-up corner of mould after 102 casts; kept in use until not safe to use further
6	116	Cracked after 72 casts; kept in use until not safe to use further

The average life of six moulds was 129·6 casts, with a consumption of 16·4 lb. of mould metal per ton of steel made. It was reported that the moulds were particularly tough to break up compared with standard moulds.

The microstructure showed a fairly even distribution of graphite in definitely finer formation than that of a standard mould. At the time of this trial, the average life of domestic standard mould was 95 and the company was advised that the German mould was giving a life of 200 casts in Germany. It could therefore be calculated that, had the values of the moulds and resulting scrap been similar, the German mould would show an advantage of 2·06d. per ton if used in accordance with English practice and an additional 1·96 per ton if used in accordance with German practice and a total of 200 lives obtained. In point of fact, of course, the German moulds were much more expensive and the value of the resulting scrap was lower. It did, however, establish these two points, namely, that the mould material of these German moulds was superior to domestic, and, secondly, that if the figures are accepted, German practice is capable of prolonging the life of the moulds to the extent stated, with the proviso that the quality of the ingot produced towards the end of the life would probably be unacceptable for many of the classes of steel and standard of inspection to which the steel makers are called upon to work in this country.

Table II.—*Analyses of Cast Iron Ingot Moulds.*

	Legrand. Per cent.	Shiokawa. Per cent.	Hruska. 1.	Hruska. 2.	Works A. Per cent.	Saar Works. Per cent.	Witkowitz. Per cent.
			Per cent.	Per cent.			
T.C.	3·25–4·95 as desired	2·5–3·5	2·5–3·5	2·5–3·0	3·4–3·9	4·0–4·6	3·9
Gr	80 per cent. of the T.C.	70 per cent. of the T.C.	Not given	Not given	70–80	80–88	3·1
Si	70 per cent. of the T.C.	1·0–2·0	1·0–1·5	1·0	2·0–3·0	1·9–2·2 not under 1·8	2·2
Mn	0·5–0·8	0·5–1·8	0·75–1·20	1·0–1·8	0·5–1·2	0·45	0·59
P	Max. 0·100	Under 0·2	Under 0·15	Under 0·15	0·08–0·12	Under 0·10	0·19
S	Max. 0·050	Under 0·06	Under 0·06	Under 0·06	0·01–0·03	0·06–0·07 0·05–0·06 preferably under 0·04 since Cu high	0·039
Cu	—	Max. 0·2	—	—	—	—	0·11
Cr	—	0·05–0·50	—	0·25–0·50	Under 0·20	—	—

Legrand.—*Fond. mod.* 20 (1926), S. 181/88. Shiokawa.—*Stahl und Eisen*, 43 (1923), p 1140. Hruska.—*Iron Age*, 123 (1929), pp. 539/41.

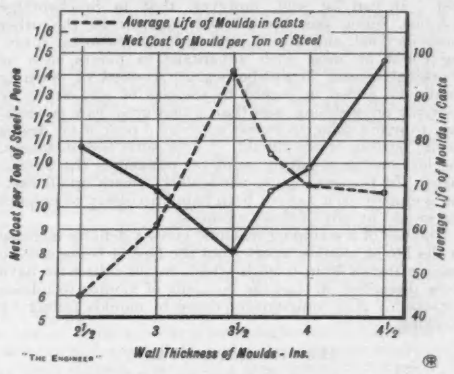
Influence of Design.

It is not within the scope of this paper to enter into a detailed statement on this particular subject. Many important papers have been read and several bibliographies are available to those interested. Quite properly, most of these papers have had reference to the influence of mould design on the characteristics of the resulting ingot, because as has before been stated, the saving of 1 or 2 per cent. in the yield of satisfactory steel is of far greater importance than extending the mould life. At the same time, a careful study of the way in which moulds fail indicates that some assistance can be given in design, quite apart from improving the quality of the mould metal.

It is also at once clear that the design of mould should have particular reference to the type of steel being made, in that the mould which is most satisfactory and economical in the one case is definitely not so in the other, when one considers the wide range of steels produced, ranging from the perfectly solid alloy steel ingot with considerable taper (probably corrugated sided) and equipped with feeder head; the larger ingots employed for semi-killed steel for structural purposes; and the mould specially designed for the most economical production of rimming steel. The factors of ratio of length to diameter, taper, shape of sides (*i.e.*, flat, convex, concave, or corrugated), corner radius, thickened bottoms, &c., all require to have careful consideration.

Having standardised the type of mould, it is possible to work out more accurately the influence of one or other variable on the economic value. One such set of experiments is given relative to the influence of wall thickness.

Having standardised the 21in. S.C.T. mould at Templeborough, a series of moulds were made having a wall thickness respectively of 2½in., 3in., 3½in., 3¾in., 4in., and 4¼in. Six moulds of each thickness were made and used under as nearly similar conditions as possible. The results fell on to a perfectly definite curve, and the results are shown below, indicating quite definitely that 3½in.



Influence of Wall Thickness on Life and Cost of Ingot Moulds Using 21in. S.C.T. Ingot Moulds at Templeborough.

wall thickness was the most economical for this type of mould. This is quoted merely as an example, and it is readily possible for any user to ascertain for himself similar data for other types of moulds. It may be added that this has since been checked on other extensive series within the region 3in., 3¼in., and 4in. for the mould in question, and the desirable thickness of 3½in. confirmed, and that in these tests such items as the complete analysis of every mould, foundry casting temperature, and conditions of use have been most carefully controlled to ensure that the comparison was valid.

The life of the mould will obviously be appreciably affected according as to whether the mould is used for running direct or casting the ingots through a centre bottom runner. The latter system is kinder to the mould, avoiding risk of cutting by the metal stream due to contact with either mould wall or bottom, but the system adopted must be decided by the effect on the steel produced rather than mould life. Another factor is the use of separate mould bottoms with open-ended moulds which give a definite improvement in mould life, whether casting uphill or direct.

It is again insisted that the ingot mould is merely a means to an end, and the first important decision to be made in any melting shop is the most suitable shape, size, and weight of ingot to give the maximum production of sound steel, together with the most advantageous method of manipulation. It is clearly important to decide in a mass production plant whether the standard ingot shall be 2½ tons, 3 tons, 4 tons, &c., and this requires to be decided alongside the capacity of the mills before the finer points of mould design can be settled.

Care and Use of Moulds.

It was stated, in connection with personal experience in the trial of some German moulds, that the life of the German moulds under specific conditions of use gave a life of 130 casts, compared with 200 casts being obtained in Germany from similar moulds. This at once indicates the importance of the method in which moulds are prepared for use and treated between consecutive casting. The basic principles underlying the care of moulds would seem to fall under two headings—first, some method to keep down the temperature to which the moulds are heated in service, and, secondly, the treatment or preparation of the mould surface to minimise deterioration by splashing and "wetting." As regards the former, practice varies considerably. In some cases moulds are quenched in water after use; in other cases, sprayed with water; in some allowed to stand for specified times on grids; and in some cases supplied with forced draught; while others rely on allowing the moulds to cool normally for not less than a specified time. Shop facilities in many cases preclude the attainment of all one would desire in regard to the resting period between casting, but such experiments as the authors have made by allowing the moulds to cool on special grids indicates a definite advantage from such treatment.

Morawa (*loc. cit.*) quotes detailed experiments in regard to the method of cooling, and finds that air-cooled moulds give the best life, but this entails a large number of moulds and much space for their accommodation. This item must

also be bound up closely with the actual composition and structure of the mould metal, in that some types of moulds would suffer much more severely than others if cooled quickly, for example, by immersion in water. It is probably clear, however, that deterioration by a breakdown of the structure of the iron must be minimised if steps are taken to reduce the maximum temperature to which the moulds are raised in service. The spacing of the moulds in setting the casting pit is obviously an important factor in this direction. A practice has recently been developed in Sweden whereby the ingot is pushed upwards in the mould as soon as it is strong enough to be moved, and allowed to rest in the mould after rotating, so that the corners re-engage with the sides of the mould. It is stated that this practice definitely results in an improvement of mould life and incidentally in the resulting product of the ingot.

Mould Facings.

Reverting to the second point, particularly if a pure soft hematite mould is being used, it is desirable that the surface shall be protected as far as possible so that the ingot will strip clean, both from the point of view of improving the ingot surface and also to prevent small pieces of mould metal being pulled away when the ingot is stripped. Numerous preparations have been used with this object of preventing steel from "wetting" the surface of the mould. These include dehydrated tar, usually thinned down somewhat, the old practice of "reeking" by burning creosote oil in the bottom of the mould, rubbing with oily waste, clay wash, aluminium paint, &c. To these are to be added a number of proprietary mould varnishes, which at present are receiving a certain measure of support on the Continent and in this country. It is quite impossible to lay down any fixed rule as to the most desirable method of preparing the inner surface of the mould. This depends essentially on the size and type of ingot being cast. It can be said, however, that in Stocksbridge practice, oiling has been found superior to the other methods tried, and that if used with discretion tar-spraying could be used with advantage in plants such as Workington and Templeborough. A word of warning should be added in regard to the use of tar, either by spraying or swabbing, and that is that great care is necessary to avoid using an excess whereby a pool of tar drains to the bottom of the mould. Under such circumstances, the loss on the resulting ingot far outweighs the advantages. In heavier ingots, particularly where uphill casting is employed, it has not been found necessary to prepare the mould by any of these methods.

The use of a stripping machine gives a definite increase in the life of moulds, apart from the fact of being able to remove ingots from moulds which would otherwise have to be discarded, in that the bumping of moulds to release "stickers" is a contributory cause of moulds failing by cracking.

How Do Moulds Fail?

Considering this matter first from the shop point of view, personal experience, which has been very carefully checked up, is that moulds fail mainly through major cracking rather than from breakdown of the mould surface. The authors noted with interest the reference by Mr. Léonard (*loc. cit.*) to this subject, where it was stated that slab moulds failed through cracks, whilst polygonal moulds finish their useful life through the deterioration of their internal surfaces. It is clearly necessary therefore to keep in mind the type of mould when speaking of the relative merits of the different factors resulting in the final failure of the mould. Speaking generally, it is clear that for any given type of mould, if a hard, brittle iron is used, and particularly if it is put into service in a state of stress, it is reasonable to expect that such a mould will crack at an early stage in its life. On the other hand, if the mould be made of very soft iron, and particularly if the graphite is coarse and flakey, then deterioration will be more rapid on the well-established principles of oxide penetration, along the graphite plates.

It seems germane to interpose here that in personal opinion the stresses in the ingot mould as cast appear to be of a serious order, and the effect has manifested itself in some cases in a rather extraordinary way. Many years ago it was found that in casting twelve-sided tire ingots of 14in., 17in., and 19in. diameter, the first ingot from a new mould was almost invariably cracked vertically in one or more of the corners. If the moulds were annealed at about 800 deg. Cent. before use, the phenomenon was avoided, and the practice was therefore adopted of always casting an ingot of slag into new moulds before using them for steel. If the stresses in the mould had such an effect on the resulting ingot, it is clear that the mould requires to be regarded carefully from this point of view if the maximum life is to be obtained. In looking at written returns from the melting shop, it is usual to see the word "cracked" as the reason for discarding, but it is necessary to analyse the meaning of the term in considerable detail. Major cracking often occurs at the top end of the mould, where, presumably, it is coolest, and, for example, in the case of 2-ton square moulds, it definitely appears to commence from the outside of the mould. It would appear that, as a result of internal stresses, and more particularly the fact that the iron cannot accommodate itself sufficiently quickly to the increase of temperature from below, cracking takes place. If the mould be fitted with liner bricks at the top or accommodates a feeder head, it may continue to be used for a long time after cracking has started, but it is very often finally thrown out because this crack has developed through the wall, and it is unsafe for further use. The larger moulds appear to fail mainly through cracks on the face, starting about the middle where the mould gets hottest and travelling downwards, while in a number of cases the transverse crack across the face occurs long before the surface has seriously deteriorated.

If a mould has not cracked, it continues in use until the surface has deteriorated to the extent of producing bad-surfaced ingots not acceptable to the mill, or ultimately on account of bad surface the ingot cannot be stripped and the mould requires to be broken off. There are, of course, the cases where moulds are scrapped with a very short life, due to bad teeming, when the side of the mould may be scored away, and rough handling in the shop, giving rise to cracking.

Sometimes the bad surface clearly develops from improper foundry conditions, and results in local deterioration. Otherwise the surface gradually develops a crazed effect, and this ultimately develops into transverse cracks. Rapid deterioration round the "plug hole" is a common failing. The mould metal is often weak in this position.

Microscopical examination through the section of used moulds is a most entertaining exercise. The authors have nothing new to add to the accepted evidence on this point, but it is certainly curious to know the wide difference in the way in which local fields have deteriorated. In some cases the spaces occupied by the graphite flakes are surrounded by a grey constituent, which is no doubt an oxidation product, and the whole of the carbide has been removed. In other fields it is possible to get perfect pearlite right up to the edge of the oxidised zone.

It has been proved by analysis that there is a slight increase in the sulphur content of the inner surface, possibly occasioned by the rapid interaction of oxide when the moulds are not in use. Careful observation has indicated that, for example, in the case of the 21in. S.C.T. mould at Templeborough, surface deterioration does not become seriously apparent until after about 70 casts, following which it develops, first gradually, and then with increasing rapidity, until the mould is unfit for service. Personal experience, therefore, leads to the following comments under this heading.

Interim Summary of Cracking.

A careful survey of the causes of mould failure indicates that the majority of moulds fail through what can be termed "major cracking," and that the principal factor causing major cracking is the inability of the material to accommodate itself to the unequal expansion which takes place when the mould is used. Mould design can assist in obviating premature failure through certain types of cracks (*e.g.*, corner cracks at the top end), while conditions of use (*e.g.*, ingot spacing in casting), as well as design, will improve moulds as regards transverse face cracking. An improvement in the quality of the material to enable it better to withstand thermal shock must also be an important line of development. Assuming the mould does not crack, but gradually develops a crazed surface due to the repeated heating and cooling, then clearly the physical characteristics of the mould metal must be looked to primarily to improve the life, together with such a system of use as to limit as far as possible the maximum temperature to which the moulds are heated in service.

Steel Ingot Moulds.

It must occur to everyone that, speaking metallurgically, mild steel ought to be far better suited than cast iron for ingot moulds. Steel moulds have, of course, been used from time to time and certain reports are available, stating extraordinary good lives, in some cases up to 700 casts. Steel moulds ought strongly to withstand failure through crazing or cracking, assuming they are made of normal mild steel. Personal experience is very limited, but a trial made some years ago was certainly not satisfactory. The trouble is, of course, that the steel mould distorts badly, and all efforts to reinforce by bends, ribs, &c., have failed to establish the steel mould as a serious competitor. The initial cost would be higher, but if satisfactory lives of the order of 500 to 700 could be obtained, it would undoubtedly become a serious competitor to the iron mould.

The simple explanation appears to be that owing to the greater elasticity of the steel mould, it distorts to such an extent as to make it impossible to cast a regular-shaped ingot and, what is more important, to strip the ingot from the mould after a comparatively short life.

Artificial means of keeping the mould cool have, of course, been tried. Many years ago, the authors experimented with a system of circulating high-pressure air round the outside mould. Water-cooled steel moulds have been suggested, but the only system of which we have knowledge, which has achieved a certain amount of success, is the water-cooled copper mould developed by Rohn* at Hanau. The exact design has been worked out very accurately and the authors have actually seen moulds that have made up to 4000 ingots and have examined ingots cast in such moulds.

The cost of the equipment for a production shop would, of course, be extremely high, and one must always bear in mind the risk of damage through mishandling. It is on this account, no doubt, that the system of using water-cooled copper moulds has not developed to a greater extent.

No attempt has been made in this paper to give any extensive references to the numerous admirable papers that have been written on this subject, but rather an endeavour has been made to state in simple language some facts concerning experience obtained over a number of years in the plants of the United Steel Companies, Ltd. Those interested are, no doubt, well conversant with contemporary work on the subject, and particular reference must be made to the work that has been done by the Heterogeneity of Steel Ingots Committee in conjunction with the Cast Iron Research Association. Further work that is going on now in collaboration with the British Federation of Iron and Steel Manufacturers will probably result in a sound development in the subject of ingot mould manufacture.

The authors would like to close, however, on the note with which this paper was opened, namely, that the quality of the steel ingot must be the first consideration; and secondly, that the value of an improved mould to the steel maker, judged from the cost-per-ton standpoint, must not be over-exaggerated.

In conclusion, the authors record their thanks to the United Steel Companies, Ltd., for permission to use the information given in this paper, which has been collected through the goodwill of the various staffs of the respective works.

The Clydesdale Navigation Company, owners of the Glasgow steamer "Blairgowrie," were last week ordered by Lord Merrivale, sitting as Wreck Commissioner, to pay £1200 towards the cost of the recent inquiry into the foundering of the vessel. Of that sum £800 is to be paid to His Majesty's Treasury, and £200 each to the solicitors for the two parties, the officers' unions and the seamen's unions, which were represented at the inquiry.

* "Zeit. f. Metalkunde," 12/1927.

American Engineering News.

American Lake Navigation.

While vast sums have been and are being spent on river improvement for inland navigation on routes where prospective traffic would pay but a small return for interest, working expenses and maintenance, the chain of the five Great Lakes presents a wonderful system of inland navigation, which requires only occasional deepening of connecting channels as the size of vessels increases. Except for these channels it is deep-sea navigation. The transportation system comprises a direct route of 1000 miles from end to end of four lakes, with a "branch" of 335 miles through Lake Michigan. The ports—large and small—are innumerable. Most of the ships are fresh-water craft, but occasionally ocean steamers from Europe traverse the lakes as far as Chicago. Of the distinctly "lake" vessels there are some 850 large cargo steamers, the largest about 660ft. long. The coal and ore traffic is enormous; 35,476,000 tons of coal in 1934—or nearly one-tenth of the coal mined that year; and 25,000,000 tons of iron ore. Much higher figures were recorded in years before the depression period. Newsprint paper and broken stone are transported in large quantities, while wheat in 1934 totalled 190 million bushels and the total for all grains was nearly 8 million tons. Ice conditions at the head of the lakes limit the navigation season to about eight months, but this year the Government used a coastguard steamer as an ice breaker, and opened a channel some weeks before the normal break-up of the ice. Passenger steamers have declined in recent years, largely owing to the private automobile, but a few lines offer a tour of the lakes for summer travel, and most of the large ports have local excursion boats. The tonnage passing through the "Soo" canal at Sault Sainte Marie, connecting Lakes Superior and Huron, aggregated 40 million tons of freight in 1933, carried by 15,220 ships—that is for the eight months' season.

American Chemical Engineering.

At a meeting of the American Institute of Chemical Engineers one subject was the design and application of induction heating for chemical process equipment, the induction heater being highly efficient from the chemical engineer's standpoint, though poorly designed according to the electrical engineer. Its advantages are ease of control and high temperatures, together with uniform distribution of heat, as compared with resistance units. To meet the requirements for greater use of phosphate fertiliser, there is beginning the production of phosphoric acid and a concentrated super-phosphate in electric furnaces of 6000 kW. Gas from the furnaces—a 10 to 1 mixture of carbon monoxide and phosphorus vapour—is burned with excess air, cooled and hydrated. The acid is collected in tanks and pumped to the fertiliser factory. An important property of the platinum metals is their high resistance to corrosion by acids and other chemical agents. Even large vessels can be made of the precious metal, for though the initial cost is high, the life is long and there is a high re-sale value. For some very important electrochemical processes the anodes are of platinum or platinum-iridium alloys. Sodium for industrial purposes is now available in cast bricks weighing from 1 lb. to 24 lb. in containers which may be stored indefinitely. It is also shipped in railway tank cars of 40 tons capacity, the car having welded on the outside steel pipe coils through which cold oil is circulated while loading and hot oil while unloading. In loading, the air is displaced with nitrogen before admitting the sodium. At one factory sodium is conveyed under a 28in. vacuum through 1200ft. of 2½in. welded steel pipe heated by electric resistance. The normal flow is 6000 lb. per hour, but is sometimes as high as 20,000 lb. Great improvements have been made in refractories; magnesite is displacing fire-clay and high-alumina brick; silica is losing its importance in metal melting furnaces owing to improvements in basic brick.

Self-unloader Steamer.

While American self-unloading steamers are numerous on the Great Lakes, enabling them to serve any port, regardless of docks equipment, their use in ocean and coasting service is limited. Considerable interest therefore has been aroused by the conversion of a former collier of the United States Navy into a commercial vessel of this class. This ship is 536ft. long, 65ft. beam, and 40ft. depth, with a loaded draught of 28ft. Twin screws and triple-expansion engines give a sea speed of 14 knots. As converted, the cargo hold is about 325ft. long, from the fore peak to boiler-room, divided into six compartments, so that different materials can be handled. Two longitudinal troughs or hopper bottoms have gates feeding two 54in. belt conveyors, which rise at the forward end and deliver to two cross conveyors jointly feeding a pan conveyor, 96in. wide, rising at an angle of 42 deg., and extending above the deck, with a total lift of 56ft. This, in turn, feeds a bin discharging on to a 54in. belt conveyor on a pivoted boom, 188ft. long, which can be swung through 226 deg. and luffed to 20 deg. above the horizontal for delivering ashore or into barges or railway cars. Each hold conveyor has a 75 h.p. motor with herring-bone speed reduction gear to a belt speed of 470ft. per minute. The cross conveyors are driven from the head pulleys of the hold conveyors. The elevating pan conveyor has a 200 h.p. motor, for a speed of 100ft. per minute. A similar motor drives the boom conveyor at 526ft. per minute, through spur gear transmission. A weighing apparatus on the boom enables accurate measurement and record of amount of material handled. The conveyor speeds can be regulated to suit the materials. This equipment is designed to discharge 1400 long tons of coal per hour, or a 10,000-ton cargo in 6 to 7 hours, but this can be reduced to 950 tons for friable material subject to degradation in handling. The hold capacity is 455,000 cubic feet, self trimmed. Power for this equipment is furnished by a 500-kW turbo-generator set taking steam at 185 lb. The crew are quartered aft, and the officers in a deck house combined with a large pilot house elevated above the break of the forecastle.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Copper and Tin.

Following the recent meeting of copper producers in London, prices displayed a downward tendency, this being mainly due to a few large selling orders. The market after the decline presented a steadier appearance, and a firmer undertone ensued. Consumption is reported to be satisfactorily maintained and a fairly active business has been transacted with consumers generally. Advices from America have been of a more encouraging character owing to the increased interest shown by consumers, and during the past few days transactions covering very substantial tonnages have taken place. One large domestic order was placed at 7·75c. per lb., and with further good buying the spot quotation is back to the 8c. level. In addition to the largely increased domestic demand in the United States, a large quantity of copper was sold to Japan. The c.i.f. Europe quotation for electrolytic at the best touched 7·95c. per lb., though the price has since dropped back to 7·82½c. per lb. According to one authority in New York, the world production of refined copper during June amounted to 120,000 tons, a decrease of about 4500 tons from the May production. The apparent world consumption totalled 120,700 tons, a reduction of about 8500 tons from the May figures. World stocks at the end of June were given as approximately 580,000 tons, a decrease of only 400 tons on the month. With a sustained domestic demand in America, there will be less fear of a revival of excessive exports to Europe. Moreover, although no specific mention was made at the recent meeting in London, it is understood that the American producers will loyally adhere to the tonnage agreed upon for export from America. . . . The artificial conditions which have prevailed on the tin market for a long time past, together with the acute shortage of metal for early delivery, made the position still more difficult this week when up to £245 was bid for standard cash with no response from sellers. This is the highest price registered for tin since 1928, when up to £266 per ton was paid. The backwardation at one time amounted to £11 10s., but with £245 bid for cash it widened to £20. Stocks in this country are being steadily depleted, and with a reduction of 400 tons on the week supplies in London and Liverpool warehouses amount to only 1318 tons, which compares with 3600 tons a year ago. Consumers are complaining strongly that they are finding it increasingly difficult to obtain the brands of tin which they desire, and there is a growing feeling that the International Tin Committee should call an emergency meeting and take immediate steps to increase supplies. Following the failure to obtain cash at £245, a small quantity was secured late in the day at £237 per ton. With stocks at such a low level and not freely available, and exceedingly high prices asked for the small quantities released, both buyers and sellers are naturally reluctant to come into the market until more normal conditions prevail. The premium on Straits is nominally £7. The increasing scarcity and the high rates demanded for Straits tin have had the effect of inducing consumers of this brand to seek other descriptions. The Banka Tin Syndicate, the Government-owned Dutch East Indies tin-mining concern, has reported that all-in production costs have been reduced from Fl. 126·22 per quintal in 1933 to Fl. 85·27 in 1934. This great decline can only partly be due to the increase in output from 8064 metric tons to 11,606 metric tons. For a long time past the Dutch tin industry has been actively engaged on increasing its efficiency by a general scheme of rationalisation, though the full benefit of this policy will only be felt when the present restriction scheme comes to an end.

Current Business.

The Furness Shipbuilding Company, Ltd., of Haverton Hill-on-Tees, has secured a contract from the Soviet Government for seven cargo vessels of 4000 tons d.w. for the timber trade. They will be fitted with triple-expansion engines, and specially constructed for steaming through ice floes. The engines are to be supplied by the North-Eastern Marine Engineering Company, Ltd., of Wallsend. William Doxford and Sons, Ltd., Sunderland, have received orders for three motor cargo ships of 9200 tons d.w. each for Stephens, Sutton, Ltd., of Newcastle-on-Tyne. Dorman, Long and Co., Ltd., have secured an order from the Russian Government for 2500 tons of steel plates. The Steel Company of Scotland has begun the replacement of "C" open-hearth furnace at its Hallside Works, Cambuslang. The new furnace will have a capacity of between 50 and 60 tons. A contract for the erection of a plant for the production of Diesel oil from British coal at the Barugh Works of Low Temperature Carbonisation, Ltd., has been placed with Simon-Carves, Ltd., of Cheadle Heath. This will be the first of its kind in this country. A new steel mill is being erected at the Albion Works of the Briton Ferry Steel Company, Ltd. The works are to be modernised by the installation of an electrically driven mill and duff-fired water-tube boilers for steam raising. Although further developments in the industry had been provided for, the company states that there is no intention at present to convert the existing mills into strip mills. The Department of Overseas Trade announces that the following contracts are open for tender:—Victoria, State Electricity Commission: Four extra high-pressure superheated water-tube boilers (Melbourne, November 11th). South African Railways and Harbours: About 380 tons of steel work for a road bridge and seven footbridges; copper and steel plates for locomotive boilers (Johannesburg, August 19th); 20,000-gallon pressed steel tank, 20ft. by 20ft. by 8ft. deep, of ¼in. plates, complete with stand 22ft. high; steel angles, channels, plates and bars for building forty main line coaches (Johannesburg, August 12th); two new steam tugs (Johannesburg, September 9th). Egyptian Irrigation Department: Centrifugal pumping plant and fittings for Malakal Stores (Khartoum, August 15th). Siam, Royal State Railways: 400 laminated bearing springs for four-wheeled wagons (Siam, August 16th). Swan, Hunter and Wigham Richardson, Ltd., Wallsend, have secured a repeat order from Bullard, King and Co., Ltd., London, for a passenger and cargo vessel, 450ft. in length, for their South African service. Last week an extension of the objects of the Consett Iron Company, Ltd., was sanctioned. We understand that the main object of the alteration is to work other metals as well as iron and steel. The company is now entitled under its new powers to engage in the business of tin-plate makers, metal founders, constructional and general engineers, shipbuilders, and ship repairers, and shipowners. The announcement is made that the firm of George H. Alexander Machinery, Ltd., of Coleshill-street, Birmingham, has purchased from Motor Industries, Ltd., the whole of the machine tool business from the former Sunbeam Works, Wolverhampton. It has also acquired part of the old Harper-Bean factor at Dudley, to which the tool business from Birmingham is to be transferred during the next few months.

Pig Iron.

Although there is normally some slowing down of operations at this period of the year, the demand for pig iron continues quite active, whilst a most encouraging feature of the buying is the fact that consumers display more willingness to buy far forward. This may be partly due to the recent advance in hematite values and a general expectation that other descriptions will also be advanced in the near future. The production of pig iron for the half-year totals 3,173,000 tons, the largest half-yearly total since 1929, whilst there is every indication that outputs will steadily increase. The market for Cleveland foundry and forge iron remains very firm, and iron-masters regard the outlook as very favourable. There is a steady inflow of fresh orders, and although they comprise a fair number of orders for small parcels for early delivery, consumers have shown more disposition to cover potential requirements. The bulk of the business, in line with recent experience, has been mainly on home account. The production of East Coast hematite appears to be insufficient for current needs, as deliveries continue on a very heavy scale. Following the quarterly meeting in the Midlands, consumers of pig iron have purchased more readily and larger tonnages of foundry iron have been ordered. Although the demand from the light castings branch has not come up to expectations, the outlet in other directions has been fairly satisfactory, and prices continue to be firmly upheld. The advance in the rates quoted for West Coast hematite has not acted as a deterrent to the demand, which has broadened out considerably during the past week, and in the Workington and Barrow area the whole production meets a ready clearance. Owing to the keen local demand and further inquiries from other districts, there has been some talk of bringing another furnace into operation in the near future. Conditions in Scotland have naturally been slowed down owing to the annual holidays, but it is a long time since conditions were so favourable for the industry. The pig iron position, consequently, gives every cause for confidence, as current deliveries absorb the bulk of the output, and sales of small prompt parcels quickly clear any surplus that remains after deliveries on contract. The production of basic iron was reported to be insufficient for the requirements of the steel works, and it is understood that considerable tonnages of scrap steel have been purchased in the United States for shipment to this country.

The Midlands and South Wales.

In the Midlands there were signs of seasonal abatement of market activity with the exception of foundry and forge pig iron. In the latter departments buying has been stimulated by a re-examination which is being made of the position, with the possibility that a new basis of prices may result. Buyers have shown refreshing eagerness to extend their contracts, and in some cases they have been able to do so. Some consumers who have been placing small orders from time to time, limiting their commitments to early requirements, have latterly shown great anxiety to cover themselves more effectually and transactions represent a considerable tonnage. A few contracts have been made for nine months ahead, and in some cases for a longer period. The market for finished iron disclosed no fresh feature, there being a steady inquiry for marked bars, with a brisk business in common bars for nut and bolt and hurdle work; but Crown bars were again a disappointing feature, whilst the call for iron strip was much quieter than of late. The demand for structural steel was somewhat irregularly placed; some producers have quite good order books, whilst others would welcome a fresh influx of business. Heavy plate mills have been making very full deliveries, which have outpaced the volume of new orders. Sections and joists in the heavier sizes are in brisk demand, but there was only a poor inquiry for lighter materials. With the advance of the season quieter conditions characterise the strip trade, but small steel bars are in rather better demand owing to outstanding differences regarding import tonnages. Recent purchases of soft billets are not being noticeably reinforced. Orders for galvanised sheets were again restricted, but makers of black sheets continue to be busily engaged. English steel for the collieries met a quiet demand, but this is not unusual at this period, and larger orders will no doubt be placed in the autumn when the production of house coal is in full swing. Prices of bright drawn steel were fully maintained, though conditions are rather quiet at the moment. In South Wales a generally confident feeling prevails, and in view of a steady demand for most descriptions of iron and steel the outlook appears to be fairly promising for some months ahead. The announcement that Richard Thomas and Co., Ltd., are to erect a modern strip mill at Redbourn, Lincolnshire, naturally aroused a considerable amount of interest and discussion in this district. The mill will be capable of producing 150,000 tons of high-grade tin-plates and sheets per annum. Using the strip process, the cost of production will be much below that obtainable at any works at present existing in this country. It is understood that the company has no intention of claiming an increased quota from the Sheet and Tin-plate Association, and, unless there is a considerable increase in consumption, this step must result in the further closing of works in South Wales. Tin-plate makers report a fair volume of oversea orders, and although these were for comparatively small parcels, in the aggregate they provided a fairly satisfactory turnover.

Scotland and the North.

With the Fair holidays in progress in the West of Scotland, conditions have been very quiet during the past week, but nevertheless the outlook for the iron and steel industry in this area is much more promising than for some years. Since the beginning of the year conditions in nearly all branches of the industry have shown a slow, but steady, improvement, and in face of the sustained home demand, work will be resumed after the holidays with a general feeling of confidence. On the Clyde the ship-repair yards have a fair amount of work in hand, but an influx of orders for new vessels would be of real benefit to this district. Locomotive builders are in a fairly comfortable position and makers of rolling stock are generally well placed. Boilermakers are reported to be well engaged, whilst tube makers have good order books to return to after the holiday. In the light castings branch at Falkirk, work has been resumed and good orders were received during the holiday interval. The restriction on Continental materials has been of inestimable benefit to steel re-rollers, most of whom will resume work on full time. Galvanised sheets were a disappointing feature, the demand for lighter gauges being very poor. The home demand for black sheets remains quite keen, particularly for the heavier descriptions, producers of which are quite busy. On the North-West Coast, steel makers have excellent order books, with indications that the demand for their products will remain unimpaired for months ahead. Producers of West Coast hematite report an active local demand, with numerous inquiries from other districts. Structural engineers in Lancashire remain fairly busy, and although only a few new contracts have been secured, they have a large amount of work in hand which calls for steady deliveries. There was more activity in boiler plates for locomotives, but progress was slow as regards tank descriptions. Steel forgings were in moderate request, whilst light steels attracted a steady volume of orders. For finished iron business has been largely confined to the common grades, but Crown bars remain in slow request.

North-East Coast and Yorkshire.

The production of iron and steel on the North-East Coast is maintained at a high rate. During the past week there was some decline in the demand for billets and sheet bars, but this is not altogether surprising, since a number of consumers have booked contracts at current prices for some months ahead. In addition, there are expectations that before the end of the month Continental suppliers will again be offering in the market for delivery after August 7th, and some users who have a partiality for using Thomas steel semis prefer to wait. The British works, however, are in an excellent position and have enough orders on their books to keep them busy for a long time to come. Manufacturers of structural material are busily employed. Structural engineers in this district and other parts of the country have plenty of work in hand, with the result that the demand for joists and sections, particularly of the heavier sizes, is exceptionally heavy; in fact, some consumers complain that works deliveries are inclined to fall into arrear. Business in railway material, as is usual at this time of the year, is on the quiet side, though some of the works are still employed on contracts taken earlier in the year. Lately there has been an improvement in the position of the shipbuilding industry and a few orders have reached this coast under the Government's scrap-and-build scheme. New business in plates and sheets has not by any means been active, and the demand for heavy plates is perhaps the weakest spot in the market. The sheet makers are moderately well employed, but home trade requirements are barely maintained. Lately, however, there has been a slight increase in export business. The Yorkshire steel industry is well employed, but the annual stop weeks have interfered with business to some extent. In most departments, however, new orders continue to be booked at a satisfactory rate. The output of basic steel in the Sheffield district continues at a high level, whilst the demand for acid carbon billets has broadened somewhat, contrary to the usual experience at this time of the year. The market requirements of wire rods, also, are heavy and not easily satisfied.

Lead and Spelter.

The recent upward movement in lead prices made rapid progress during the past week, owing to an exceptionally active demand for the metal in this country, keen buying by several Continental countries, and an expanding demand in America. With relatively small supplies available and expectations of a helpful statement from the conference in progress in London, prices registered a sharp advance with forward foreign lead sold up to £15 6s. 3d., which brings prices to the highest point seen since 1932. As consumption in this country continues to be maintained at a high level with no indication of a falling off in the quantity absorbed by the Continent, there is every likelihood that the present level of values will be upheld.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teeside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teeside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/- rebate*)	3 10 0	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/- rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/- rebate*)	3 10 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 14 0 d/d Glasgow	
	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 10 0	—
No. 4 „	8 0 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

LONDON AND THE SOUTH—	Home. £ s. d.	Export. £ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ⅜in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ½in.	9 10 0	8 5 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6 .. 7 15 0 to 8	5 0

STEEL (*continued*).

GLASGOW AND DISTRICT—	Home. £ s. d.	Export. £ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 10 0	8 5 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ⅜in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ½in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 10 0	8 15 0
14-G. to 20-G., d/d	10 15 0	9 0 0
21-G. to 24-G., d/d	11 0 0	9 5 0
25-G. to 27-G., d/d	11 12 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2.
Tin-plate Bars, d/d South Wales Works, £5 5s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/-
„ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/-
„ „ „ 1 p.c. carbon	£36 5 0	11/-
„ „ „ 0·70 p.c. carbon	£37 5 0	12/-
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, July 24th.

COPPER—		
Cash	£31 16 3 to £31 17 6	
Three months	£32 3 9 to £32 5 0	
Electrolytic	£35 0 0 to £35 15 0	
Best Selected Ingots, d/d Birmingham	£35 10 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9¼d.	9¼d.
„ Brazed	11¼d.	11¼d.
TIN—		
Cash	£233 5 0 to £233 10 0	
Three months	£223 15 0 to £224 0 0	
LEAD: Cash and forward	£15 6 3	
SPELTER: „ „ „	£14 15 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	13/- to 13/6
„ Glasgow—Ell	14/6
„ „ Splint	17/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/- to 13/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6 to 14/-
Unscreened Navigation	13/- to 13/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	12/6 to 13/-
Secondary Steam	11/9 to 12/-

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/- to 16/-
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	13/6 to 14/-
„ Second	13/3 to 13/6
„ Best Small	10/6 to 11/-
Unscreened	12/- to 13/6
DURHAM—	
Best Gas	14/8
Special Foundry Coke	19/- to 20/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	23/- to 25/-	—
South Yorkshire Best	20/- to 22/-	—
South Yorkshire Seconds	17/- to 18/6	—
Rough Slacks	8/- to 9/-	—
Nutty Slacks	7/- to 8/6	—

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 26/-
Foundry Coke	25/- to 40/-
Furnace Coke	19/- to 21/-
Patent Fuel	21/-
SWANSEA—	
Anthracite Coals:	
Best Large	36/- to 40/-
Machine-made Cobbles	35/- to 48/6
Nuts	35/- to 48/6
Beans	26/- to 31/6
Peas	22/6 to 23/-
Rubbly Culm	11/- to 11/6
Steam Coals:	
Large Ordinary	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Foreign Trade Facilities.

THE Government is proceeding with its plan to balance the Budget on the assumption that it is futile to ask the nation to make sacrifices to wipe out the present deficit unless it can provide means to ensure sufficient revenue to cover all expenditure in the future. That revenue can only be obtained from a development of home production and from duties on imported goods. This fiscal necessity postulates that the duties must be on as high a scale as imports will bear without suffering unduly from them, and that an increasing volume of imports must be accompanied by expanding exports, and, consequently, by a general industrial activity that will swell the State revenue. It is intended to reverse the country's economic policy which aimed at obtaining industrial prosperity by shutting out foreign goods and monopolising the home and Colonial markets. But that policy has acquired so great a momentum that the task of reversing it will be difficult. Its failure has not changed the outlook of industrial interests, which fear that disaster may follow upon the suppression of quotas. They will accept no risks at a time when inaction will almost inevitably bring about disaster, and the only alternative to decrees substituting higher import duties for quotas, and introducing trade facilities, is the preparation of a plan for dealing with the problem as a whole, with no prospect of its being adopted soon enough to save the situation. In present circumstances nothing can be done with a plan that aims at protecting all interests. Restrictions that paralyse trade and industry must be removed at the risk of some industries permanently suffering in order that others may increase their activities and bring about an early general recovery. Safety is to be found in partial measures of an effective character which the Government can enforce by decree if it continues to act with the same courage as it showed in cutting down the national expenditure. How urgent is the necessity for action is seen in the foreign trade returns for the first six months of the year, showing that exports have dropped to the lowest figure yet reached, while a reduction of nearly 2000 million francs in the value of imports, compared with the first half of 1934, is no longer regarded with feelings of unmixed satisfaction.

The Navy.

In presiding over the launching of the cruiser "Marseillaise" from the yard of the Chantiers de la Loire at Saint-Nazaire last week, the Minister of Marine, Monsieur Piétri, stated that with the ships being constructed the tonnage of the French Navy will this year reach 700,000. That figure includes about 400,000 tons built under the existing programme. The Navy, he said, is homogeneous, with the largest number of submarines, the fastest destroyers, and half a dozen 7600-ton cruisers oft he most modern type, the first of which, the "Galissonnière," has given results in trials that justify expectations in the speed and handiness of this cruiser squadron. Monsieur Piétri had previously visited the yard where the "Strasbourg" is being laid down, and affirmed the intention of the Government to push forward the building of the two 35,000-ton battleships and to reinforce the Navy, which must be strong if the country is to preserve its friendships abroad.

Petrol Substitutes.

This country is poor in fuels of mineral origin but rich in vegetable resources capable of producing substitutes for petrol if only they can be employed satisfactorily and economically. Efforts that continue to be made to achieve that end are explained as much by a desire to be independent of imported oils in times of national emergency as by the necessity of providing a practically unlimited source of profit to agriculture. The State monopoly of industrial alcohol, mainly from beet, costs the country a considerable sum of money annually, despite the increased consumption of the spirit mixed with petrol in commercial vehicle engines, but the quantity of alcohol employed for that purpose represents only a small fraction of the total amount of spirit used in road vehicles. The failure of the State to impose a mixture of alcohol and petrol on all motor car users showed that there can be no compulsion when car owners refuse to employ a fuel that offers no advantage in economy, and is often a cause of trouble and inconvenience. The only way to solve the problem of a "national fuel" is to continue research, experiment, and demonstrations, with the aid and encouragement of State agricultural and military departments and of associations interested in the production of these fuels, so that with improvements in methods of adapting engines to run on them, it will be possible to convince car owners that they can effect economies by using fuels that are hardly less convenient than petrol for starting and acceleration. One such demonstration was the run from Rome to Paris which terminated last week, when French, Belgian, and Italian military and private cars and lorries covered 1700 miles in three weeks, including speed and consumption tests on the way, notably over the Sarthe circuit. The tests were under the control of a military commission. The fuels employed included wood and charcoal, ground nut oil, shale oil, and other home and Colonial products, and the number of vehicles completing the run under exacting conditions showed that progress continues to be made in wood and charcoal suction gas equipment and in specially designed engines with carburetting devices for the use of vegetable oils. For military transport there is already a wide range of home-produced fuels available, and it is partly on account of their being liable to mobilisation that industrial vehicles have to use an alcohol-petrol mixture, but private motor car owners will probably wait a long time before they will be provided with a satisfactory substitute for petrol at a cost which will allow of some margin of economy to the user. Alcohol for mixing with other engine fuels is sold at a price that leaves no profit to the State. For the moment, the fuel problem is centred in the lorry and omnibus, and the use of suction gas is steadily increasing on account of its low cost. Nevertheless, the economy may be illusory, when, as happened during the recent hot weather, a fire that destroyed 4000 acres of forest in the Aube department was traced to a suction gas lorry.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

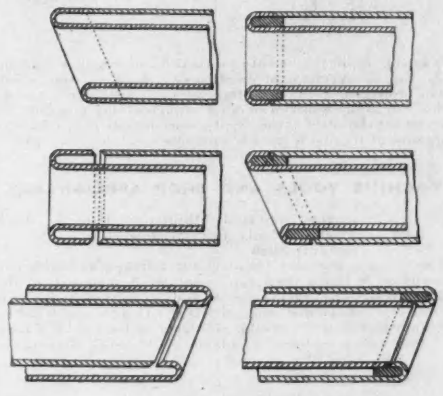
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

430,140. November 6th, 1934.—SUPERHEATER TUBES, J. Krieger, Engineer, at Louvroil (Nord Department), France.

This invention relates to improvements in the manufacture of steam superheater elements, comprising two concentric tubes connected together at their ends so as to form a chamber having an annular cross section, and in which the steam to be superheated circulates. These elements are adapted to be externally and internally heated by combustion gases, one of their ends opening on the fire side and the other in the smoke-box. The connection of the two concentric tubes, at each of

Nº430,140



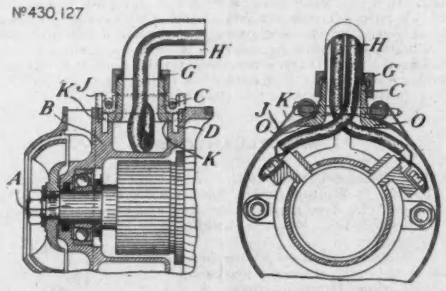
their ends, has up to now been obtained by welding both tubes either directly one to the other, at their ends, which latter can be enlarged or shrunk for that purpose, or on a ring inserted between their ends. This method of manufacture is suitable for the end adjacent to the smoke-box, but it has proved to be unsatisfactory for the furnace side. As a consequence, the inventor folds back the end of one of the tubes, and makes the weld, as shown in the drawings. In this way the weld is protected from the direct action of the heat. The sketches show several alternative arrangements, some of which are reinforced with a ring.—*June 13th*, 1935.

DYNAMOS AND MOTORS.

430,127. July 30th, 1934.—CABLE CONNECTING DEVICES, G. Steiner, 6, Schaererstrasse, Solothurn, Switzerland.

As is well known, when interruptions of an electric circuit occur, either intentionally or unintentionally, as, for instance, in the case of interrupters for magneto electric ignition apparatus or at the commutator of electric current generating machines or electric motors and the like, electro-magnetic waves are produced at the sparking places, which have a disturbing effect on radio apparatus. Such places, as well as all connecting cables, must be completely enclosed in a metallic casing. The invention consists in a screening connection of cables in screening pipes to electric apparatus, comprising a connecting device through which the cables pass from the cable screening pipe to inside the electric apparatus, and a strap round the periphery of the apparatus which screens the internal parts of the apparatus to the outside and secures the connecting device on the apparatus. In the drawing, A is the armature shaft and B is the bearing cover at the commutator end. C is the connecting device

Nº430,127



to which the cable screening pipe H is coupled by means of the cap nut G. The connecting device C is located in position on the commutator bearing cover B by two pins D, and held on this bearing by means of the strap J, which at the same time completely encloses the commutator and the brush holders. In each of the two loop-shaped ends of this strap a bolt and two tensioning screws are provided. The cable connection is effected in a very simple manner as follows:—The connecting device C with the cable pipe H is placed together with the drawn-in cables on the commutator bearing cover B and the cables themselves are connected to the brush terminals. The strap J is thereupon placed round the commutator bearing cover B, the tensioning screws are inserted, and tightened up. The strap will then bear against the cylindrical part O of the connecting device C, which is in this way held tightly on the commutator bearing cover. Through the strap J the commutator and the brushes which are always a cause of sparking are completely screened to the outside, a complete screening of the entire current generating plant being thus ensured.—*June 13th*, 1935.

FURNACES.

430,257. December 15th, 1933.—BURNERS FOR PULVERISED FUEL, J. Watson, 5, Hareshore-road, South Wellfield, Earsdon, Northumberland.

In this burner the pulverised coal is fed in, together with a supply of primary air at slightly above atmospheric pressure, through the pipe A. This pipe is provided with helical vanes to produce a whirling action. At the front end of the burner there is a cone B, which is supported by other helical vanes. This cone is supplied with secondary air through the pipe C

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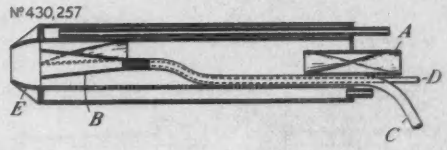

and with gas through the concentric tube D. The burner is air jacketed for cooling purposes, and has a heat-resisting outlet cone E. The gas supply is used for heating up purposes on starting with coal having a low proportion of volatiles.—*June 17th*, 1935.

ELECTRICAL APPLIANCES.

430,253. December 15th, 1933.—MERCURY THREAD CUT-OUTS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2, G. S. Campbell Lucas, 75, Eastlands-road, Rugby, and C. G. Mayo, 17, Alexandra-road, Rugby.

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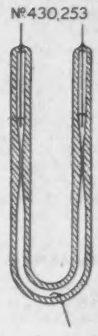

This cut-out acts to break the circuit in the event of it being overloaded by the vaporisation of a thin thread of mercury. It consists of a U tube of glass with restricted portions in each leg, which are of capillary proportions. At the upper end of each leg there are connections, dipping into the mercury, which are connected with one pole of the circuit through a change-over switch. At the bottom of the U there is another connection for the opposite pole of the circuit. Should the instrument be overloaded, the thread of mercury in one of the legs will be ruptured by volatilisation, and the pressure thus produced will force the mercury back into the other capillary passage, should that thread of mercury have already been ruptured. Then by operating the change-over switch, the circuit can be completed again.—*June 17th*, 1935.

TRAMWAYS AND RAILWAYS.

430,254. December 15th, 1933.—ELECTRIC DETECTOR MECHANISM FOR TRACK POINTS FOR RAILWAYS, A. G. Kershaw and the Westinghouse Brake and Saxby Signal Company, Ltd., 82, York-road, King's Cross, London.

This is an apparatus for indicating the condition of the setting and locking of point tongues. The points are operated by the bars A and B, which are provided with notches at C and are locked by the doubly notched bar D. A floating lever E is pivoted on a sliding block F with the pivot fixed to the base plate. The opposite end of this lever is connected with a contact

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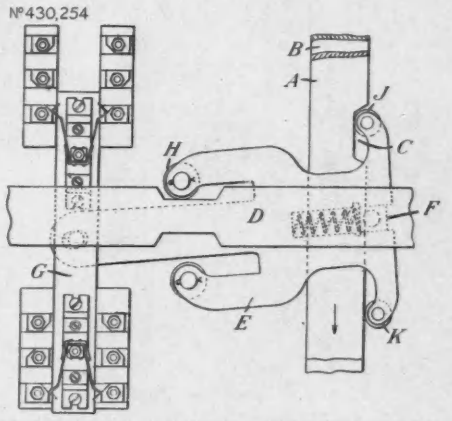

bar G, while there are triple contacts on either side. In the position of the lever illustrated, the points are open, with the rollers H and J in the notches of the point and locking bars. The lower pairs of contacts are then engaged, and an appropriate signal is sent to the cabin. On the withdrawal of the locking bar, the lever is brought to the mid position by the roller H and another signal is given. The lever is held in this position while the point bars are reversed, and then the roller K drops into the notch and as soon as the locking bar is restored the lever swings over to the upper contacts and a third signal is made.—*June 17th*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

430,261. December 16th, 1933.—PNEUMATIC TIRES, The Dunlop Rubber Company, Ltd., 32, Osnaburgh-street, London, N.W.1; E. W. Madge, F. B. Jones, and D. Parkinson, Fort Dunlop, Erdington, Birmingham.

The object of this invention is to provide an improved adhesion between the elements constituting the body of the tire of a nature such as to provide a greatly increased resistance to forces tending to separate them whereby the efficiency and capacity for service of the tires shall be greatly enhanced. In particular the invention aims at preventing the development of tread, undertread or casing ply looseness in particular between rubber-cotton joints in the tire. Accordingly the tire is characterised in that the separation resistance of the rubber-textile junctions is increased by the presence of discontinuous fibres in the layers of rubber in contact with the textile material. The fibres may be carded or combed fibres and may be initially coated with rubber prior to their introduction into the rubber compound which ultimately forms the rubber layer in contact with the textile material. One or more layers of rubber containing fibres may be interposed between the undertread and breaker strip or strips. Alternatively or in addition, one or more layers of rubber having embedded fibres may also be interposed between the breaker strip or strips and the cord or fabric plies constituting the body of the casing.—*June 17th*, 1935.

MINING MACHINERY.

430,128. August 10th, 1934.—FIXING WHEELS ON TUB AXLES, Ruhrhandel G.m.b.H., 1, Preselweg, Hagen-Haspe, Germany, and C. Schuck, of 6, Steinstrasse, Hagen-Haspe.

In order to make the wheels of mining tubs secure on their axles, yet readily removable, the inventors forge on to one end

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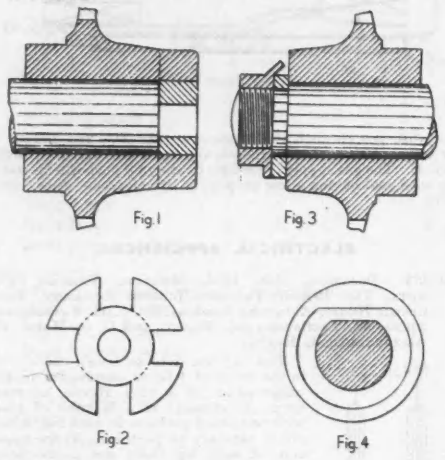

of the axle, as shown in Figs. 1 and 2, a star which engages with corresponding recesses in the hub of the wheel. This wheel is the fixed one. At the other end of the axle there is the loose wheel—see Fig. 3. This wheel is secured by a washer with a flat (see Fig. 4), and a nut with a tongue, which is bent down to engage the flat.—*June 13th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

430,141. November 24th, 1934.—FLOW METERS, The Electroflo Meters Company, Ltd., F. V. A. E. Engel, and A. L. Hancock, all of the Company's Works, Abbey-road, Park Royal, London, N.W.10.

This is a meter for measuring the flow through a Venturi flume or over a weir by measuring the differential head and the actual head and compounding these readings according to the formula $Q = k\,w\,h_2\sqrt{h_1 - h_2}$, where Q = the rate of flow, w = the width of the throat of the flume or the width of the weir, h_1 = the level of liquid in the upstream of the flume or the height of liquid above the crest of the weir at the upstream side thereof,

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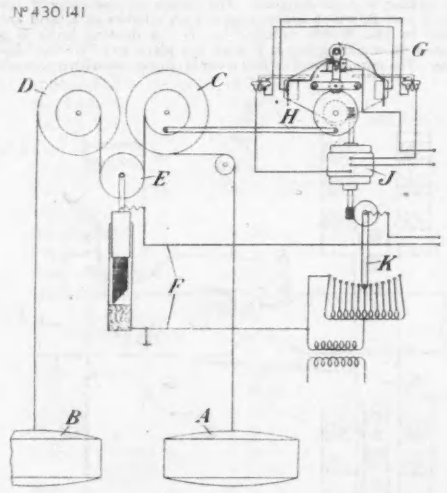

h_2 = the level of the liquid in the throat of the flume or the height of liquid above the crest of the weir, and k = constant. The float A is situated in the throat of the Venturi and B on the upstream side. They are suspended by cords from the differential pulleys C D E. The pulley E operates an Electroflo device of the type already described in THE ENGINEER to vary the current in an electric circuit F. The pulley C is connected with the relay device G by the link H. The relay, in conjunction with the reversible motor J, operates the contact arm of the auto-transformer K and further modifies the electric current, which can be used in any convenient way for indicating and recording the flow.—*June 13th*, 1935.

ORDNANCE AND ARMOUR.

430,134. October 16th, 1934.—SILENCERS, H. Coanda, 9, Boulevard Haussmann, Paris, France.

This invention relates to silencing devices for firearms, internal combustion engines, and the like, and is based upon the lamination of the gas in thin sheets. If a high-velocity gas is projected into the air through a very narrow slit, the sheet which escapes may be given a direction determined by the braking effect of the adjacent surrounding atmosphere at one side of the sheet, the optimum curve to be described by the sheet of gas which escapes being a function of its mass, speed, and the physical constants of the surrounding atmosphere. With these factors it is possible thus to change the direction of the direct reaction of the gases escaping into the surrounding atmosphere and to allow, while facilitating it, their escape without noise. If the gases are guided for a substantially long period so that their expansion may absorb their temperature, which facilitates their evacuation still more, there is obtained at the same time an improvement in efficiency and in outlet velocity and the absence of noise. Referring to Fig. 1, the barrel A of a firearm is provided, at a short distance from its muzzle B, with orifices C, through which the gases escape into an expansion chamber D formed between the barrel A and a sleeve E arranged on the barrel. The expansion chamber D opens into the atmosphere through substantially narrow channels or slits F which are inclined to the axis of the chamber D. The wall of each slit on the sides nearest the butt end of the gun is extended beyond the outer ends or orifices G of the slits and thus forms a boss portion H—see Fig. 2—adjacent that side of the slits. This boss portion H upsets the equilibrium of the blast effect produced in the surrounding air and gives the stream such a direction that it licks the walls of the boss following the path indicated by the arrow J. Since these exhaust gases react in the opposite direc-

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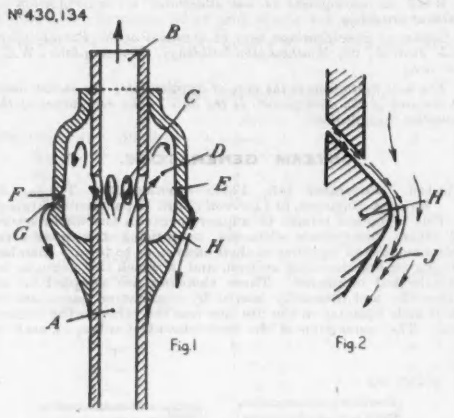

tion to the recoil, they create by their displacement a vacuum at J—Fig. 2—avoiding the creation of a shock reaction which would propagate itself, as in the case of ordinary firearms, by giving rise to the well-known crack of present-day firearms. In this manner the effect of the recoil is considerably reduced at the same time as the shock wave is eliminated.—*June 13th*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

429,769. December 7th, 1933.—MOULDING PRESSES, John Shaw and Sons (Salford), Ltd., Wellington-street Works, Salford; and J. B. Shaw.

This press is intended for moulding cellulose and such like materials. It has a fixed top crosshead A mounted on the columns B B. The lower crosshead C slides on these rods and is operated by the two hydraulic rams D D. This crosshead carries the lower half E of the mould. Hanging on the rods F F from the upper crosshead there is a middle crosshead G carrying the

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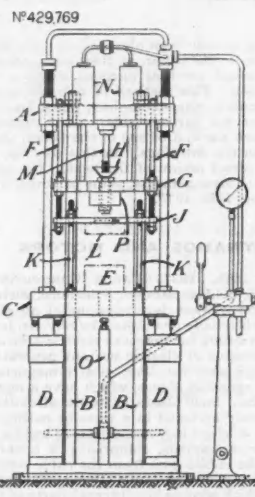

filling spout H. The rods F F can slide up through the top crosshead. Another plate J is hung on the rods F F and can be pulled down by the rods K K. It carries the upper half L of the mould. In operation cellulose is placed in the spout H and the rams D D operated to close the two parts of the mould. Further upward movement closes the two plates G and J together and the cellulose is injected by the ram M. On completion of the moulding the rams D D are reversed and the rams N N used to push down the plate. A stripping bar is provided at O and an electric heater at P.—*June 6th*, 1935.

MISCELLANEOUS.

430,258. December 15th, 1933.—A BLASTING CARTRIDGE, J. Taylor, 7, Winton Circus, Saltcoats, Ayrshire; and W. Young, 118, Argyle-road, Saltcoats; and Imperial Chemical Industries, Ltd., Millbank, London, S.W.1.

This cartridge is intended for bringing down coal and aims at producing a relatively slow bursting effect. A steel tube container is fitted with an electric ignition plug A and is capable of withstanding pressures up to, say, 25 tons per square inch. Leads are taken from the plug to the powder fuse B. The tube is loosely filled with explosive C and closed by a perforated cap D, which is completed by a bursting disc E. It will be appreciated that the cartridge is generally used in a horizontal position; hence the contour of the explosive shown, but this is not essential. A typical example of the charge is:—70 grammes of a mixture of ammonium nitrate and ammonium oxalate in the proportion of 3 : 1 by weight mixed with 55 grammes of granular black powder and placed in a rigid container of the liquid carbon dioxide blasting type having a capacity of 360 c.c. and provided with a steel disc of 0·11in. thickness shearing at 12 to 13 tons per square inch. The cartridge is placed with its disc end towards the back of a bore-hole in coal, and is initiated electrically with the aid of a suitable igniter, such as 5-grain powder fuse.—*June 17th*, 1935.

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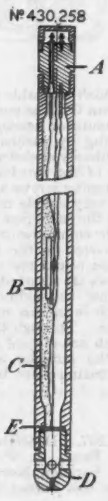

429,771. December 7th, 1933.—ELECTRIC CABLES, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

Wound end sleeves for shutting off electric single or multi-core cables filled or impregnated with oil or other filling or impregnating compound have hitherto been constructed in the most varied ways. All forms of construction, however, had one thing in common, that is, adhesive or binding material had to be used for obtaining sufficient tightness. Thus, for example, between the individual paper or band layers, adhesive material was introduced, or, instead of adhesive material, layers of a soluble impregnating material—for example cellulose bands were arranged between the individual layers of the binding, which, by being coated with an appropriate solution, became closely connected together so as in this manner to obtain a corresponding sealing against exudation of the oil or other filling or impregnating compound. It has been shown that the materials hitherto used were not always equal to the requirements as a result of the constantly varying temperature of the cable. According to the invention, an end sleeve comprises an elastic and plastic material which is oil and heat resisting—for example, polymers of acrylic acid, derivatives of acrylic acid, such as acrylic acid esters as well as their homologues, also polyvinyl compounds separately or mixed together. This material is employed in tape form, applied under tension in one or more layers. In the case of an end sleeve made in such a manner, as a result of the plasticity of the material, the joints between the individual turns of the wound layers are so tightly closed that no exudation can occur. Since, on the other hand no adhesive or binding medium is used, the sealing layers retain their elasticity. Thus there is no danger with subsequent varying of the form, as a result of temperature fluctuations, that any cracks to other leakages may occur in the cable. The illustration is self-explanatory.—*June 6th*, 1935.

Nº 429,771

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. J. G. LEGG, late of Hoover, Ltd., has been appointed works manager at the Manor Mills Works of the Hercules Motor and Cycle Company, Ltd., Birmingham.

FLANNERY, BAGGALLAY AND JOHNSON, Ltd., of 9, Fenchurch-street and 2 and 3, Philpot-lane, London, E.C.3, inform us that, owing to conversion to the automatic system, their telephone number has been changed to Mansion House 3758.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE STANTON IRONWORKS COMPANY, Ltd., Nottingham, has received an order for large diameter spun iron pipes to the value of over £50,000 from the municipality of Skoplje, Yugo-Slavia.

HAYWARD TYLER AND CO., Ltd., London and Luton, has secured the order for forty-eight duplex cargo oil pumps and 132 other duplex steam pumps for twelve tankers of the Anglo-Saxon Petroleum Company, Ltd.

RICHARD DUNSTON, Ltd., of Thorne, Yorkshire, has received orders for the construction of eight steel barges for London owners, two petrol-carrying tank barges for service on the Thames, a steam tug for Hull owners, and a Diesel-engined tug for service on the river Ouse. The barges will be built at Messrs. Dunston's Thorne yard, and the two tugs at their associated yard, Henry Scarr, Ltd., Hessle, near Hull.

BRITISH TIMKEN, Ltd., Birmingham, has received, among others, the following orders:—Fifty-four axle-boxes from the Mersey Railway, Liverpool, for six new third-class electric trailer cars; bearings for the tenders of three "YK" class 4–6–2 locomotives now being built by the Hunslet Engine Company, Ltd., Leeds; the engines are being built for the Assam Bengal Railway; a set of tapered roller bearing axle-boxes for fitting to one eight-wheeled tramcar for the Hobart tramways. This is a conversion from the ordinary type of bearing and the tramcar has been so equipped as an experiment. It is understood to be the first time that anti-friction bearings have been fitted to tramcars in Tasmania.

LAUNCHES AND TRIAL TRIPS.

DUNTROON, motor vessel; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Melbourne Steamship Company, Ltd.; dimensions, 470ft. by 65½ft. by 36ft.; to carry passengers and cargo. Oil engines of Harland and Wolff-Burmeister and Wain-Kincaid type, constructed by J. C. Kincaid and Co., Ltd.; launch, April 4th, 1935. A speed of 19 knots was attained on recent trial trip.

TEMPERATURE CHART.—We have received from Hadfields Ltd., of Sheffield, an interesting chart having down the centre a temperature scale running from 1300 deg. Cent. to absolute zero—273 deg. Cent. On the right of this scale with brackets to show the range over which they are suitable for use are tabulated types of alloy steels and irons; and on the left, besides some notice of the class of engineering dealing in such ranges of temperature, there are shown the trade marks of the Hadfield products suitable for the various ranges. Copies of the chart are obtainable on application to the firm.

THE CRYSTAL PALACE.—On Thursday evening, July 18th, 1935, the Trustees of the Crystal Palace held a reception. The guests were received by the Rt. Hon. J. H. Thomas and Sir Henry J. Buckland. The function was the occasion of the completion of the restoration of the Architectural Courts and the inauguration of Brock's season of Crystal Palace fireworks. During the evening H.R.H. the Duke of Kent made a tour of the courts. The Crystal Palace is a national institution, and the Trustees and the artists who have assisted in the restoration work are to be congratulated on the pleasing results of their labour. We noticed a collection of models of locomotives, steamships, and other mechanical subjects, which should be an additional attraction to visitors.